Knowledge.

With which is incorporated Hardwicke's Science Gossip, and the Illustrated Scientific News.

A Monthly Record of Science.

Conducted by Wilfred Mark Webb, F.L.S., and E. S. Grew, M.A.

DECEMBER, 1913.

STELLAR SPECTROSCOPY FOR BEGINNERS. II.

By PROFESSOR A. W. BICKERTON, A.R.S.M.

Sound and Light.

We speak to one another by means of the vibrations of air; the stars tell us their story by the movements of a medium we call ether, which is perhaps best conceived of as a highly elastic jelly. We cannot see the air, but we can feel it, and when it moves swiftly enough it may knock us down or hurl us over a house. We can neither see nor feel the ether, yet able men tell us we have more proof of the existence of ether than of matter, while some think matter is ether in motion. Air and other matter are made up of little moving particles of extreme minuteness called "atoms."

Atoms.

A popular way of putting the size of atoms is to say that there are more atoms in a drop of water than drops of water in the Atlantic Ocean.

Perhaps the best way of realising some of the properties of atoms is by means of a little instrument Sir William Crookes made and called the spinthariscope. By means of this pretty toy one can see the effect of swift atoms of helium hitting a surface of sulphide of zinc, each blow producing a flash of light. The point of a needle is coated with a little radium and placed in front of the zinc surface, which thus becomes luminous. Solid radium is for ever breaking up into other elements and becoming a heavy and a light gas, and it takes two thousand years for radium to half become gas. In thus changing, each heavy atom of radium loses a light atom of helium and becomes the atom of another heavy element called "niton," or "radium emanation," which is a gas. The element helium is extremely important in stellar spectroscopy, and we require to know a lot about it; at present we want to form an idea of the minuteness of the atom. The zinc surface, with the radium-coated needle in front, is put at the back of a little brass box with a small convex lens in front. This instrument is called a spinthariscope or scintilliscope. On looking through the lens in a perfectly dark room, each individual atom of helium as it strikes the sensitive surface makes a flash of light. One sees hundreds of such flashes each second. In some spinthariscopes this has been going on for years, and will do so for thousands of years more without much apparent diminution of the number of escaping atoms of helium. Heat or cold makes no apparent difference in the speed of escape of the helium atoms, and no physical or chemical treatment seems either to hurry up or in any way change the rate at which these atoms—the so-called "alpha particles"—leave the radium. Such, then, is the minuteness of the atom.

An atom, although so small, is of wondrous complexity, but for purposes of spectrum analysis we had best think of them as little spherical bells flying about in all directions, ringing for a little time after they hit one another, and, like bells, ringing true to tone. Like other bells also they alter the character of the note according as to how hard and how often they are struck. Heat makes atoms move faster, and so when a gas is heated the particles hit harder, and more overtones are produced. There is a wonderful complexity in these atomic overtones; the atom of iron gives off thousands; some atoms seem to be much less complex. Many atoms seem to be like compound bells, as though made up of many bells of different tones fixed together.

XUM

Helium appears to be a very complex atom; in fact it seems to be an inseparable double atom, each part being groups of bells. In it, however, one characteristic tone rings out so clearly that midst the complexity we can recognise helium by a line of a pure yellow tint.

COLOUR.

The vibrations of a sheep bell we call sound; those produced by the atoms we call colour; so it is by colour the stars tell us their story. In the spectrum the pure tints of singing atoms stand apart, each in its proper place and so form the cipher messages that reveal the mystery of the stellar heavens. These ciphers are being gradually deciphered and read by our industrious observers.

But "when the mind is blind the eye does not see." What are wanted are guiding hypotheses, and on all sides workers are awakening to this need. Now their want is felt, the keys to open the doors of the mind to see the richness of the corridors of space and the many mysteries of Creation will surely be forthcoming.

Some of these cosmic keys were found a long time ago, but have only just begun to be used; yet already they have opened up many rich realms of Nature.

VIBRATIONS.

Sound and light are both examples of propagation of vibrations by wave motions. One gains a good idea of wave motion by watching a field of ripening wheat when moved by the wind. The waves travel the length of the field, yet one knows the individual heads remain each on its own stalk; each constituent of the wave only oscillates. Ear after ear moves in succession, and so the motion looks to be one of translation.

If a stone be thrown into the middle of a still lake, the disturbance starts a series of waves that travel until they reach the margin of the water. Yet although the waves travel outwards, a cork on the troubled waters merely moves up and down.

The speed of the wave depends on the elasticity and density of the medium; elasticity increases and density diminishes speed. Elasticity in the air is perhaps best understood by resistance to compression. Make the air in a football hot, and it resists compression more, and is more elastic. The reason is that the particles of air fly faster. The velocity of a sound wave in a gas depends on the speed of the moving molecules of the gas. Thus, at the same temperature, hydrogen particles move four times as fast as oxygen particles. So sound travels four times as fast in hydrogen as it does in oxygen.

A tuning fork strikes a gas particle as a bat does a ball, and it bounces away a minute degree quicker than it came. It hits its next particle more quickly than normal, and so a wave is produced. Sound waves are often many feet in length and travel one thousand one hundred feet a second. Light waves are many thousands to the inch, and travel one hundred and eighty-six thousand miles a second.

A tuning fork may only move one hundredth of an inch. Yet it produces waves of sound that travel thousands of times as fast as its own motion, and the speeds of these waves differ whether they be transmitted by gas, liquid or solid; for example, if they travel in air, in water, or in glass.

The curious thing is that the wave travels fastest of all in the densest of these three substances. Not, however, because it is dense—density reduces the speed of progression—but because it is more elastic; it recovers from compression more energetically. How are we to explain these phenomena? We may do so as suggested by imagining the tuning fork to be a bat, hitting swift molecular balls thrown by a demon bowler. The bat causes the balls to bound back quicker than they come. In the case of liquids and solids potential energy of molecular and cohesive attraction has been converted into molecular kinetic energy, so the molecules oscillate quicker than in gas. Molecular and cohesive attraction make the liquid and solid more elastic.

LIGHT.

A beam of common white light is one of the most complex things in existence. The waves of sunlight are of many lengths and move in many planes. In this respect the motion of sunlight is more complex than the motion of the air when stirred by an orchestra.

The vibrating particles of air, as the waves come from a musical instrument, move in the line of propagation towards and away from us; not so light. In the ether waves the motion is across the direction from which the light is coming. As the waves enter the eye the motion may be horizontal, or vertical, or in any plane. In common light they move in all planes—in all azimuths, as astronomers say. When they are sorted out so as to move in a single plane we say the light is polarised. An instrument called the polariscope is used to so sort the waves of light. A sound wave cannot be polarised; its sides do not differ. In plane-polarised common white light the ether moves in one plane only, but its waves are of many lengths. It is the work of the spectroscope to sort the waves into their different lengths. Light consisting of such separate waves moving in one plane is said to be pure monochromatic polarised light. A ray of polarised light of any pure tint is the simplest conception we can have of any beam of light. We picture it best by imagining a tightly stretched skein of silk being jerked, and watching the waves travel along the length of the silk. Let us imagine an atom of sodium to be vibrating, and picture the successive motions in the ether as moved by the yellow beam of light after it has passed through a polariscope. Some transparent crystals have a structure like a gridiron with very close bars. These minerals only allow the vibrations of light to pass in one plane. Such a crystal is a polariscope; there are many more effective kinds of polariscopes, but the action of these crystals is easy to imagine.

Polariscope phenomena are not often studied in spectroscopy, and will not here be further developed.

REFRACTION OF LIGHT.

A wavy line is a fair representation of a simple ray of light of a pure tint polarised in a plane (see Figure 515). In this each particle has moved on its upright line, and the wave has advanced. A beam of common white light is made up of myriads of such waves of different lengths moving in different planes. It is the duty of the spectroscope to sort and to spread these mixed colours into a long strip in which the waves of different lengths stand out distinctly in the order of their speed or length. This sorting is effected by

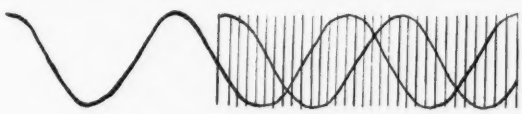


FIGURE 515.

prisms or by a parallel set of very close, fine lines ruled on metal or glass, and called a grating. We will try to understand the action of a prism on a ray of light. As long as a beam of light travels in a

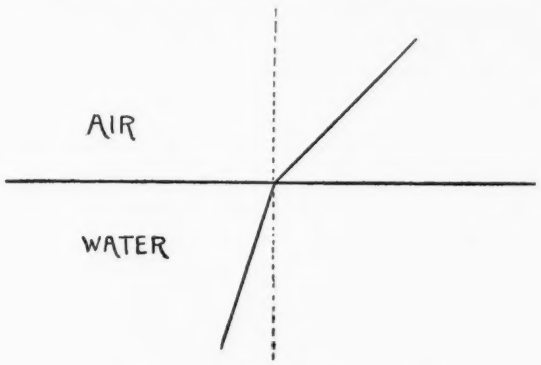


FIGURE 516.

uniform medium, such as still air or still water, it moves straight forward at a uniform speed. In

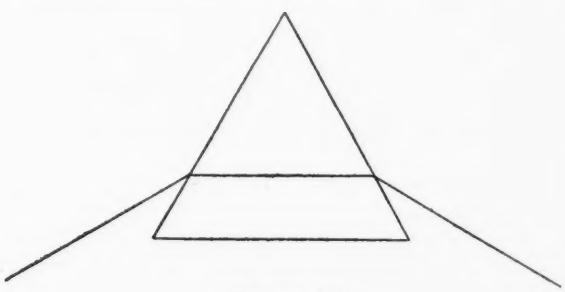


FIGURE 517.

passing from one medium to another a beam of pure light alters speed, and if it falls obliquely on the plane surface of separation it is bent at an angle. If the ray be a pure tint it is bent as in Figure 516. If the pure ray pass through a prism of glass it is bent both on entering and leaving, as in Figure 517.

REFRANGIBILITY OF LIGHT.

A white beam of light may be made up of two pure complementary colours. The best colours to

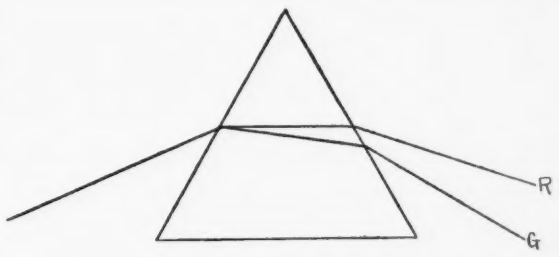


FIGURE 518.

use are green and red. If such a white beam passes through a prism the two colours are differently bent, and so separated as in Figure 518.

The white beam of light from an "Osram" filament lamp has a myriad of different wave-lengths. Those the eye can see, range from about thirty-three

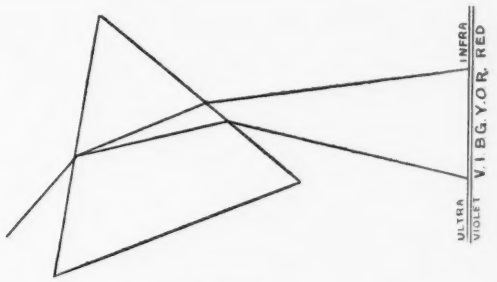


FIGURE 519.

thousand to sixty thousand to the inch. In this case the prism separates them into a rainbow-tinted streak with the red at one end and the violet at the other, in the order shown in Figure 519. The red is

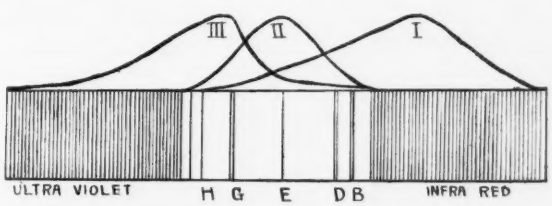


FIGURE 520.

least bent; then in order come orange, yellow, green, blue, indigo, and violet. All the colours shade into one another and there are thousands of tints, each

of a different wave-length. In popular lectures, to give an idea of what has happened, I use the simile of a crowd.

SIMILE TO PICTURE A SPECTRUM.

If a strong light shone on a crowd dressed in all the colours of the rainbow, at a distance the crowd would appear to be clothed in white.

Suppose the crowd of many thousands to be made up of individuals of all heights, the tallest about twice as high as the shortest. The tallest are dressed in deep red, then as they are shorter the tint gradually becomes crimson, then passes to scarlet, to orange, to yellow. The individuals of intermediate height are yellow-green, still shorter blue-green, then follow all the tints of blue, of indigo and violet down to the lavender-grey, which some eyes can see and others cannot. Colour-blind men might not be able to see the tall ones. Eyes differ in their power to see the two ends of the spectrum. All the crowd exactly keep up with one another. The tall red fellows stalk along, and the little weak violet ones run to keep up, the size of the stride representing the wave-lengths of various coloured light. Every individual proceeds forward in an exactly straight line. Then they come to the prism; it is a strong turning impulse. Imagine a blast of wind blowing at right angles to the travelling crowd. It turns them all a bit, but the little weak ones, the violet, are turned much more than the strong red, and all the intermediate tints are turned in proportion to their speed of step or their shortness or weakness. All three ideas are important. Then, after passing the impulse of the prism, again they go straight forward. If the crowd be a very narrow one it corresponds with a narrow slit. At once it begins to sort itself into its constituent colours. The crowd broadens as it travels; after a time instead of a mixed crowd its front is a long orderly line of individuals, a rainbow-tinted streak, a spectrum, with the short violet waves running at one end, and the tall red stalking along at the other end. Supposing the individuals of a certain height were truants, there would be a gap, as when the electric arc shines through a sodium flame. Supposing there be many truants of different wave-lengths then there will be many gaps, and we get the analogy of the solar spectrum.

HEAT AND CHEMICAL ACTION.

White solar light is even more complex than the coloured crowd: there are taller fellows than the longest red and shorter than the shortest violet; they are in invisible grey, and the eye cannot see them. The long waves are strong and the short waves tricky. The big slow waves act as robber brigands; they can knock a whole molecule and start it flying. The little waves are weak thieves that cannot deal with a whole molecule, but can steal his atoms.

The invisible ultra-violet waves are better pick-pockets than the strong invisible infra-red. In the solar spectrum the greatest energy is in the heat-waves at and beyond the red end. The chemical or actinic power of the spectrum is near and beyond the violet end. The long waves are heating because they move the whole molecules; the short waves are photographic because photography depends on loosening and breaking up the molecule. The chloride of silver is pulled to pieces and the silver deposited by the quick vibrations of light that are not powerful enough to do much in the way of moving the whole molecule and so heating the compound. The height of the parts of the three curved lines in Figure 520 gives the value in the entire solar spectrum of its three properties; that is, its energy or heat, its light as it affects the eyes, and its actinism or power to pull molecules to pieces. The power to pull to pieces is also feeble energy, so energy is in all parts of the spectrum; but generally the higher the temperature the greater is the ratio of light to heat and the actinic power to the total energy. Generally, also, the higher the temperature, the greater the number and complexity of overtones the atoms produce as they strike one another. Heat being molecular indiscriminate motion, the velocity of molecules increases with the temperature. If a platinum wire be heated by an electric current and used instead of a slit, and looked at with a prism fixed over a hole in a large card with the parallel edges of the prism held parallel to the platinum wire, a good spectrum of the hot wire will be seen. Of course, one does not look directly towards the wire, but in the direction the rays are bent by the prism. When current is such that the wire is just visible a r[illegible]ass of light is seen. As the resistance is lessened and the current increases, the wire brightens, and as it does so the red glow spreads to orange, then yellow is added, and other successive colours of the rainbow show themselves. When the platinum is near its fusing point, a magnificently perfect spectrum of great purity is produced. Thus we see the effect of increased temperature in extending the spectrum towards the violet; that is, in increasing the speed of movement of the molecules and consequently lessening the wave-lengths. This is the effect when we heat a solid; because its molecules cannot move freely, it is like a mass of touching bells from which by shaking we can only get a jangle of noise and no music. The tightly fixed atoms of a solid have no room for free motion, so they can only jangle and give waves of every kind.

When a bell rings alone it gives a musical note, and when a vibrating atom is free in a rare gas it gives colours; often of many very pure tints.

The colours in the spectrum of a star tell us its story. The instrument we read the cipher message with is the spectroscope, and the tale it tells us depends on our understanding the laws of light and widely correlated sciences.

(To be continued.)

XUM

From a photograph *by J. H. Worthington.*

FIGURE 521. Flash spectrum obtained near Ovar, Portugal, 1912, April 17th, during a total solar eclipse, with a prismatic camera consisting of a 2·1 inch Achromatic Quartz and Rock-salt lens of 50 inches focus with two 50° Quartz prisms in front of it. Exposure, about ¾-second. The photograph from which this is taken is unique.
(See "KNOWLEDGE," November, 1913, page 408.)

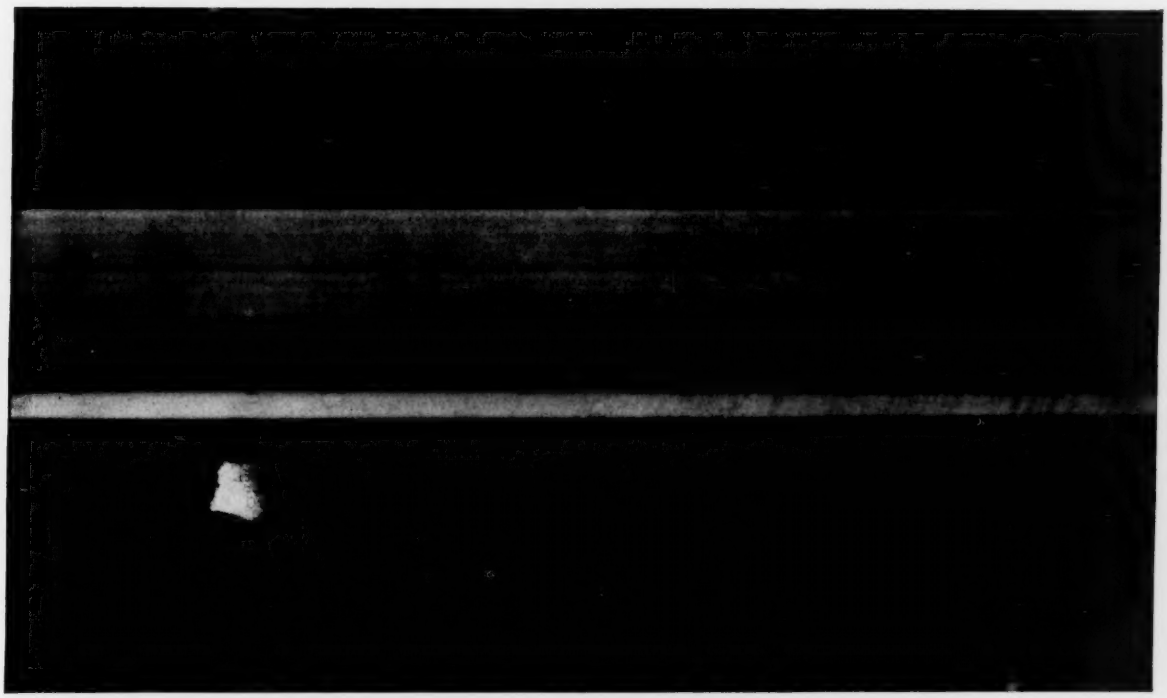
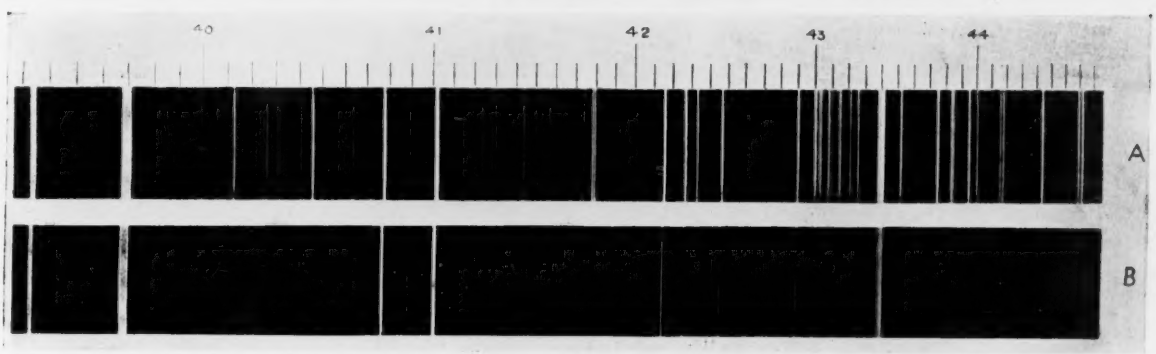


FIGURE 522. An enlargement of a portion of the flash spectrum shown in Figure 521.



From spectrograms taken with a 2-prism flint spectroscope *by E. H. Hills, Pulgaon, India, January 22nd, 1898.*

FIGURE 523. A* and B†, spectra showing the flame bands of the reversing layer of the Sun seen during an eclipse. Compare the definition and straightness of the lines in these spectra, photographed through a slit, with the circles in Figures 521 and 522.

* At point of second contact. † At point of third contact.

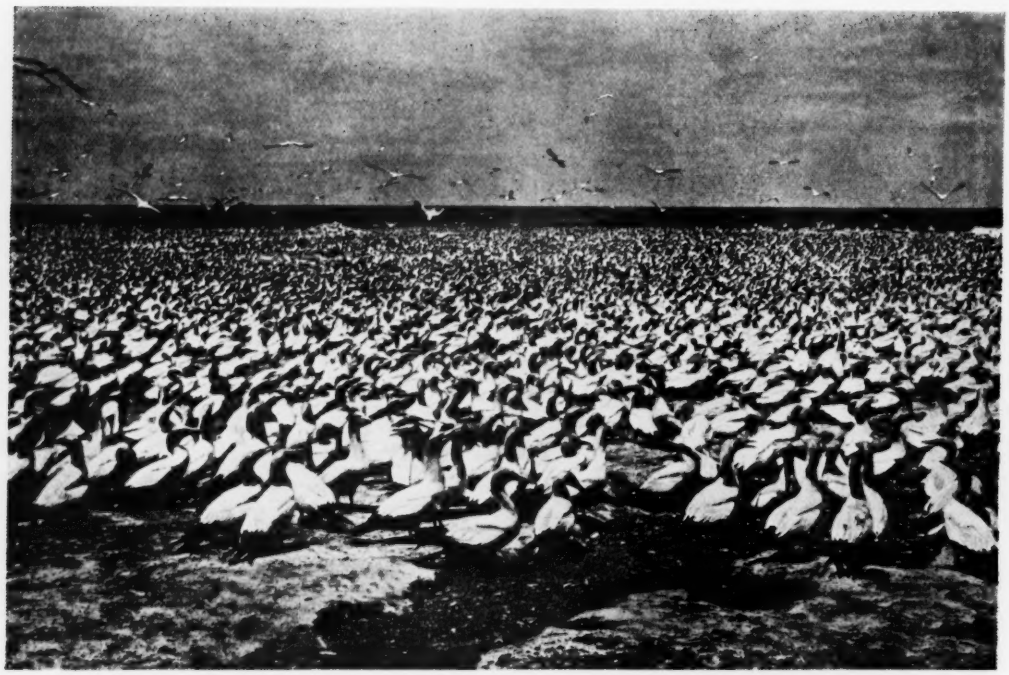


FIGURE 524. Gannets in the Southern Hemisphere: *Sula capensis* on Bird Island.

FIGURE 525. British Gannets: *Sula bassana* on the Skellig, Ireland.

(From "The Gannet," by J. H. Gurney, by the courtesy of Messrs. Witherby & Co.)

REVIEWS.

AVIATION.

Aviation.—By ALGERNON E. BERRIMAN (late Technical Editor of *Flight*). 360 pages. 32 illustrations. 6¾-in.×5¾-in.

(Methuen & Co. Price 10/6 net.)

Mr. Berriman has attempted a Herculean task. He has not only endeavoured to cover the entire ground of a tremendous subject, but he has aimed at producing a book that shall appeal to the whole range of possible readers—from the tyro whose knowledge of flight is limited to a single visit to an aërodrome, to the experienced aviator desirous of understanding the rationale of his movements in the air, or the aëroplane constructor aiming at the perfect machine.

In a measure the author has accomplished the feat. In one sentence he explains that an aëroplane does not flap its wings; in another he becomes severely technical over the differential negative warp. Some really admirable simple examples and experiments, that the schoolboy will delight in, are followed by formulae of Pressure and Resistance Constants. This is well enough, but the reader of the entire volume is left wondering whether the attempt has really been worth while, or whether the schoolboy and the aviator may not both be slightly disappointed.

The only conceivable way in which such a task could be accomplished is in a series of separate articles, and it is of this that the volume with its twenty-four appendices really consists. But the arrangement of these chapters might well have been improved upon. The chronology is intentionally turned upside down, but the result is a loss of sequence and coherence. Many things come over twice; nor does the choice of subjects always seem wise. A description of the various makes of aëroplanes would have been more interesting than the Official Report of the Military Trials of 1912.

Nevertheless the book is inspiring and one to delve into; for it is full of good things. The debt that aviation owes to Sir George Cayley is acknowledged more fully than ever before, and it is pointed out how aëroplane gliders might have been in use centuries before any sort of engine was known. "If the brave spirits of those times had sought to emulate the soaring feats of birds, there is very little doubt but that a man at the present day would be as much at home in the air as he is, for example, in the water."

It may be questioned, by the way, if Mr. Berriman's description of the sensation of flying is the general experience. It is not the writer's, at any rate.

If this book is not wholly satisfying, it is at least brimful of information and interest. It is extremely well illustrated and produced.

G. B.

CHEMISTRY.

Rubber and Rubber Planting.—By R. H. LOCK, D.Sc. 245 pages. 32 illustrations. 7¼-in.×4¾-in.

(The Cambridge University Press. Price 5/- net.)

So many industries are now dependent upon a plentiful supply of rubber that a book which describes in a simple manner the nature of indiarubber and the science and practice of planting the trees, should meet with a wide welcome. The authoritative account given by Dr. Lock is not only extremely interesting to read, but should also be of real value to the prospective rubber planter and to those who wish to interpret the prospectus of a rubber company.

Separate chapters are devoted to the physiology of the latex, planting and harvesting operations, and the pests and diseases to which the plant is liable. The book does not profess to deal exhaustively with the chemistry of the subject, but an outline is given at sufficient length for a non-chemical reader, while there is a clear summary of the different processes used in the manufacture of rubber goods.

The description of the industry gains much by the illustrations, which include ten full-page photographs of methods of tapping the rubber, diseased trees, apparatus, and so on, and excellent line drawings, specially made by Mr. Denton Sayers, of the different species of rubber-producing plants.

C. A. M.

Osmotic Pressure.—By A. FINDLAY, D.Sc., F.I.C. 84 pages. 2 illustrations. 9-in.×6-in.

(Longmans. Green & Co. Price 2/6 net.)

The latest addition to the Monographs on Inorganic and Physical Chemistry is written by the general editor of the series, and deals with the subject of osmosis upon similar lines to those followed in the preceding monographs. Readers of "KNOWLEDGE" will recall the wonderful osmotic forms described by M. Leduc, and his remarkable theories as to the part played by osmotic processes in the development of life. It is another of the points of contact between physics, chemistry, and biology, and biologists in particular will welcome the appearance of a book which can be used as a laboratory companion. The subject is not intended to be exhaustively discussed, for the aim of the monographs in this series is to summarise the present condition of knowledge in each branch and to bring together the results of investigations which are widely scattered in scientific publications all over the world. References to the original papers and a full index increase the value of the book to the practical worker, while the general student of chemistry will here find an excellent outline of this branch of physical chemistry.

C. A. M.

Organic Chemistry for Advanced Students.—By J. B. COHEN, Ph.D., B.Sc., F.R.S. 427 pages. 8¼-in.×5¼-in.

(Edward Arnold. Price 16/- net.)

In this work Professor Cohen amplifies and extends the course of lectures which he published six years ago, so as to give, not only a general historical survey of the rise of organic chemistry, but also an account of the recent researches showing the connection between physical properties and chemical structure.

Although full references are given at the foot of each page to the original publications quoted in the text, the book is intended rather to guide the student in the direction he may profitably explore than to serve as a reference handbook.

Starting with an outline of the history down to Kekule's theory, the author proceeds to discuss the valency of carbon, and summarises the facts which tend to prove that, contrary to the belief which was long regarded as almost an axiom, carbon need not necessarily be tetravalent, but may be tervalent or bivalent.

In the following chapters full outlines are given of the nature of organic reäctions, of their dynamics, of the relationship between physical properties and structure, and of colour and structure, and the book concludes with a good index of authors and a subject index. The various theories, which are not infrequently in conflict, are discussed at sufficient length, the arguments for and against them being fairly presented.

It is difficult to overrate the value of this book to the student. Organic chemistry was for far too long a time merely a storehouse of an immense accumulation of facts which were apparently uncorrelated. The aim of each investigator was to prepare a new crystalline compound, and so add another substance to the long list. But now the order underlying all these disconnected facts is gradually being unfolded, and this book of Professor Cohen will help all who seek its aid to grasp the new conceptions which are modifying the whole course of organic chemistry.

C. A. M.

XUM

GEOGRAPHY.

Japan's Inheritance (the Country, its People, and their Destiny).—By E. BRUCE MITFORD, F.R.G.S. 384 pages. 12 maps and plans, and 75 illustrations from photographs. 9-in.×6-in.

(T. Fisher Unwin. Price 10/6.)

More than half the book describes the physical inheritance of Japan, mainly from a geological point-of-view, laying special emphasis on volcanic phenomena; here, as in all parts of the work, the author describes many personal experiences which give the reader a vivid impression of local conditions. Excellent photographs illustrate his descriptions; one longs for a better physical map. He adds a sober account of the present-day state of affairs in the country, warning us that the West and the East have only half learnt each other's lessons, so that there is danger ahead: America has not learnt to treat Orientals with due respect, and Japan, inevitably to be linked with China, has acquired no spiritual foundation to counterbalance its new materialism. Japan has a definite mission to the East, which can only be fulfilled satisfactorily if these defects are remedied. The book is well worth reading.

J. C. C.

The Continent of Europe.—By LIONEL W. LYDE, Professor of Economic Geography in University College, London. 446 pages. Physical maps of each country, and many diagrams. 9-in.×6-in.

(Macmillan & Co. Price 7/6 net.)

In a closely-written book of over four hundred pages, Professor Lyde gives us a very interesting study of Man in Europe, as influenced by geographical factors such as surface-features and climate, based upon Europe's characteristic peninsular formation. For the sake of this study, he is prepared to accept the tetrahedral theory of the development of world-forms as a convenient working hypothesis; the surface-relief is examined in relation to this and its effect on the movements and habits of Man. His intimate knowledge of economic conditions and their correlation with the various physical controls renders the book worthy of careful study; he makes one realise that in the long run geographical conditions must play the fundamental part in shaping the characters and destinies of countries and their inhabitants. In Europe, especially, human history and sentiment count for so much that he rightly groups his matter around political units rather than "natural regions," and he shows great scientific ingenuity in tracing geographical influences in history. It is a most inspiring book.

J. C. C.

OCEANOGRAPHY.

The Ocean.—By SIR JOHN MURRAY, K.C.B., F.R.S. 256 pages. 12 plates. $6\frac{3}{4}$-in.×$4\frac{1}{4}$-in.

(Williams & Norgate. Price 1/- net.)

It is not easy to do justice to this excellent manual of Oceanography in a short review. From his great knowledge of the subject Sir John Murray has condensed into two hundred and forty-three post octavo pages a very extensive account of the Ocean from almost all points of view. In fact the book is so full of the latest facts and contains so little "padding" that it will serve almost as a textbook or work of reference for *Fachleute*, as well as a manual for the interested amateur. After detailing the methods of research, Sir John Murray passes on to the depth, salinity, and temperature of the Ocean. The difficult problems of "why the sea is salt" and why the percentage of carbonate of lime is so small in the waters of the ocean are explained, though perhaps hardly so fully as might be wished by the unlearned. We have not found reference to the recent suggestion that the sea contains much decomposing organic matter which may be made use of by many organisms hitherto believed to live entirely by the holozoic method of nutrition.

Tides and tidal waves are next touched upon, followed by an account of the difficult question of ocean circulation, the interesting condition of the Black Sea being sufficiently explained in the limited space at the author's disposal, though we think the Gulf Stream hardly receives sufficient attention. Plant and animal life are next dealt with, and the first part of Chapter VIII is perhaps the most interesting and stimulating portion of the book; the latter half is mostly a catalogue. The plates of marine organisms at the end of the book are rather too sketchy to be of much value. We note that Figure 16, Plate VIII is upside down. The nature of the marine deposits is very ably described and the author gives in this connection sundry cogent reasons for disbelief in "Atlantis" and "Gondwanaland." Finally the structure and interrelation of the various geospheres are discussed in a highly interesting manner. We can confidently recommend the book to all those—and they must number not a few—who would learn, from one who is *facile princeps* among living experts, something of the "wonders of the Great Deep."

M. D. H.

ORNITHOLOGY.

The Gannet. — By J. H. GURNEY, F.Z.S. 567 pages. 131 illustrations. 9-in.×6-in.

(Witherby & Co. Price 27/6 net).

A striking testimony to the interest which is now being taken in British birds is Mr. J. H. Gurney's book on "The Gannet," for he devotes no less than five hundred and sixty pages to his subject. His sub-title is "A Bird with a History," and no one after reading his latest contribution to ornithology can deny that the Solan Goose has a long and interesting story. There was, some years ago, a fear that the Gannet might die out. We are glad to think with Mr. Gurney that its numbers are increasing, and that its fish-eating propensities are overlooked, while the traffic in its feathers is ended and the name Solan Goose is quite forgotten in the "trade." It is to the description of the bird's habits that many no doubt will turn. The fact that the birds show a considerable amount of affection for one another and indulge in caresses after the period of courtship is over, is of interest, as well as the curious way in which the birds gape from time to time, and the number of accidents which are responsible for their deaths. It might be deduced from the facts that the Gannet only lays one egg and takes three years to come to maturity that it is long lived, and a marked bird is said to have reached the age of eighty years. Mr. Gurney's book is really most exhaustive and fascinating, and goes into every kind of detail. On page 446 we are permitted to give two out of the many well-chosen illustrations.

PHYSICS.

Researches in Magneto-Optics.—By P. ZEEMAN, Professor of Experimental Physics in the University of Amsterdam. 219 pages. 74 figures. 9-in.×6-in.

(Macmillan & Co. Price 6/-.)

The discoverer of the well-known "Zeeman effect" dedicates his monograph to the memory of Michael Faraday. The book itself is not unworthy of such an association. In clearness and completeness of exposition, in true scientific enthusiasm, and in generous recognition of the work done by others, it is a fit successor of the "Experimental Researches." To criticise such a book in a brief notice would be an impertinence, and to deal with it adequately would require more knowledge than the writer of these few lines possesses. He is capable, however, of appreciating the clearness with which the distinction between dispersion and resolving power of a spectroscope is made in the opening chapter. The book is an expansion of Professor Zeeman's lecture given at the Royal Institution in 1906, and has been written specially for Macmillan's series of science monographs. The translation of the Dutch manuscript seems to have been admirably done by Miss J. D. Van der Waals. The last twenty-five pages are filled with the bibliography of the subject. Evidently the book is one which every student of Physics should possess.

W. D. E.

STELLAR PHOTOGRAPHY FOR AMATEURS.

By W. H. STEAVENSON, F.R.A.S.

CONSIDERING the large and important part now played in astronomy by the photographic plate, it is strange that comparatively few amateurs are actively interested in this branch of the science. No doubt most users of telescopes have tried their hand at photography at some time or another, but such attempts are too often limited to the taking of a few snapshots of the sun or moon in the principal focus of the instrument, which is then applied once more to some line of visual work with results that are generally of questionable value. Without wishing for one moment to discourage useful visual work, it is the aim of the writer to show the great possibilities of stellar photography from the point of view of the amateur and to suggest a few branches of astronomical work to which he may profitably apply it.

A few words on the subject of equipment may not be out of place. A common mistake on the part of beginners is to attempt work on too large a scale, using the biggest apertures and longest foci at their command. After what has been done by Roberts, Keeler, and Ritchey, however, it is doubtful whether many amateurs could make any useful advance in the photography of individual clusters and nebulae. It is in small-scale and wide-field work that the average amateur will find it most profitable to engage. The exact size and make of the lenses used must, of course, be largely a matter of individual choice; but whatever choice is made there are at least two qualities which a lens to be used for stellar work should possess, namely, great rapidity and great covering power. Slow lenses may, of course, be used, but the necessary exposures will be so long that it will be hardly worth while to use a lens whose aperture is less than *f*5 or *f*6. Unless expense is no object it is perhaps best not to try to combine extreme rapidity and good covering power in one and the same lens. It is much better, if possible, to have two lenses—a portrait lens for rapid work on small areas and an anastigmat for large fields. The portrait lens should have a working aperture of *f*3 or *f*4, and should be of at least twelve inches focus. Such lenses are often to be picked up quite cheaply in second-hand shops. Their covering power is rather poor, and if the focus is not above twelve inches or so there is no point in using anything larger than a quarter-plate with them. As a rule their limit of fair definition does not extend beyond a circle eight or ten degrees in diameter. The anastigmat should be of about eight inches focus, should work at *f*4·5 or *f*4·8, and should cover a half-plate sharply at its full aperture. Under such conditions the lens will cover an area in the sky of thirty by forty degrees, or considerably more than four times the area enclosed by the four chief stars of Orion. The portrait-lens and the anastigmat may be used simultaneously, thus acting as mutual checks on each other's work. If they are used separately, the former will obviously be employed for detailed work on small areas, while the latter will be used when it is necessary for any purposes to cover a large region of the sky at once. Of course, for all photographic work necessitating long exposures an equatorial stand is absolutely essential; but it may be a very simple one, and need not even be provided with a clock. The latter adjunct is an obvious advantage as a saver of labour, but, given the requisite patience on the part of the operator, excellent results may easily be obtained with hand driving alone. Unless the telescope is a large one it is best to attach the cameras as counterpoises to the instrument, as this saves unnecessary weight, which is apt to militate against smooth and easy driving. For guiding, the out-of-focus image of a star, bisected by cross-wires in the eyepiece of the telescope, should be used. In order to correct for refraction, a slow motion in declination is essential. Care should be taken to follow accurately to within a few seconds of arc, as even small errors are much more noticeable on photographs than might be expected.

It now only remains to indicate in a general way some of the uses to which such lenses as those mentioned above may be put. First there is the search for variables and *novae*. In this branch of work it is best not to try to cover too much ground at once, but to work systematically on one small region at a time, preferably with the portrait-lens. A small part of the sky, in or near the Milky Way, should be selected and photographed repeatedly with the same instrument at intervals of a few days, the plates being carefully compared by superposition or some other method. For the detection of short-period variables it is best to make several exposures of equal length and at equal intervals on the same night, moving the camera slightly for each exposure. The result will be a number of images of each star, which will be of equal intensity in every case, unless there is in the region a variable undergoing rapid change at the time, in which case it can at once be detected by the inequality of its various images. This method has been used with good results by Professor E. C. Pickering at Harvard.

Another use for the photographic lens is in the search for comets. For this the anastigmat, on account of the large field it covers, is especially suitable. A region of the sky not too far from the

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sun should be chosen, and the photograph taken as near to the time of sunset or sunrise as the length of the twilight will permit. The writer would particularly recommend this branch of work to observers living in or near the tropics, where the twilight is of short duration. For the actual study of the changes in comets' tails the portrait-lens, on account of its rapidity, is more suitable than the anastigmat, though both may be used.

The visual study of the paths and radiants of meteors may very profitably be supplemented by work with the camera. Owing to the rapidity of their flight, only the brighter meteors will record themselves, but a few definite lines on a measurable plate will be of more value in determining the position of a radiant than any number of loose statements based merely on eye-estimations. Though not strictly speaking "stellar" in character, comets and meteors have been included in this article as being objects which are photographed under essentially the same conditions as the stars themselves.

There are many other ways in which photography can help the amateur astronomer. Its value as a means of map-making is considerable. It is often desirable, for the identification of faint satellites and for other purposes, to have an accurate map of some region which shall show all stars down to a fairly low magnitude. To those who cannot afford to buy the Franklin-Adams charts or the Astrographic Atlas, a home-made map, made in an hour or two with a portrait-lens, will often be very useful.

THE ALCHEMICAL SOCIETY.

AT a meeting of the Alchemical Society held Friday evening, November 14th, a paper was read by Madame Isabelle de Steiger, entitled "The Hermetic Mystery," the chair being occupied by the acting president, Mr. H. Stanley Redgrove, B.Sc., F.C.S.

Madame Isabelle de Steiger's interpretation of the theories and aims of the ancient and mediaeval alchemists differs radically from that accepted by many students of the history of philosophy and science, her views in the main agreeing with those expressed in that well-known but exceedingly rare work, "A Suggestive Enquiry into the Hermetic Mystery and Alchemy."

According to the lecturer, the doctrines underlying Alchemy were the primitive doctrines at the heart of every ancient religion. Alchemy, she maintained, was not concerned with metals but with man, whom the alchemists endeavoured spiritually to perfect through a process analogous to that said to have been discovered by Mesmer. The Alchemists, she said, formed a sort of free secret order, and their writings were cryptogrammatic, being intended to be understood by one another only. They were couched in the language of chemistry to mislead the ignorant, on account of the danger attendant upon any misuse of the processes with which they dealt.

The full text of the lecture has been published in the November number of the Society's Journal.

THE EXHIBITION OF THE NATURE PHOTOGRAPHIC SOCIETY.

SOME three years ago, through the initiative of Mr. Carl Edwards, of Leeds, the Nature Photographic Society came into existence, That there was a place for it soon became evident. A large majority of the leading nature photographers including Messrs. Edward J. Bedford, Richard Kearton, F. Martin Duncan, Oliver G. Pike, and John J. Ward, joined the ranks of the members, and the organisation became a distinct success, while a quarterly journal entitled *The Nature Photographer*, has since appeared regularly. If in the olden times all roads led to Rome, nowadays most things find their way to London, and last year the Annual Meeting of the Nature Photographic Society took place in the metropolis, and what is more, the first exhibition of photographs by members of the Society was held during the months of October and November by the courtesy of the Royal Photographic Society of Great Britain at its house in Russell Square. It may be said at once that an excellent series of pictures was brought together and that Mr. H. Armytage Sanders, who acted as organising secretary of the exhibition, was able to fill all the space which had been kindly placed at his disposal. As the movement in favour of nature photography arose out of the interest which was first of all taken in the hunting of British birds with the camera instead of the gun, it was to be expected that photographs of birds would be well represented. Of them we ought to mention particularly the gannet landing at the nest taken by Mr. Charles Kirk with a "Birdland" Camera, the adjutant bird in two studies of expression by Mr. Edward J. Jacob, who sent also a very beautiful picture of a swan. Many of the movements which are caught by the camera look quite unnatural and are far from being like drawings, so that those who say that nature photographs should always be what is called artistic do not understand their value and are talking rank nonsense. Such past masters in the art of bird photography as Mr. Bedford, Mr. Kearton, Mr. Pike and Mr. Sanders, were also represented, and we are glad to see that Miss Grace Kearton is following in her father's footsteps. Fungi and flowers were fairly well represented; the reproductions of Mr. Essenhigh Corke's colour-photographs were very striking. The president, Mr. Henry Irving, the secretary, Mr. Carl Edwards, as well as Mr. Somerville Hastings, sent pictures of fungi. Mr. Hugh Main illustrated the life-histories of insects and the habits of millipedes: his photographs of the musk beetle we are able to reproduce on page 451.

FIGURE 526.
Larva in stem. Natural size.

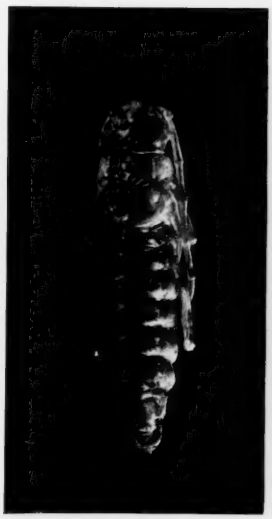

FIGURE 529.
Larva, lateral view × 2.

FIGURE 530.
Larva, ventral view × 2.

FIGURE 527.
Pupa, dorsal view × 2.

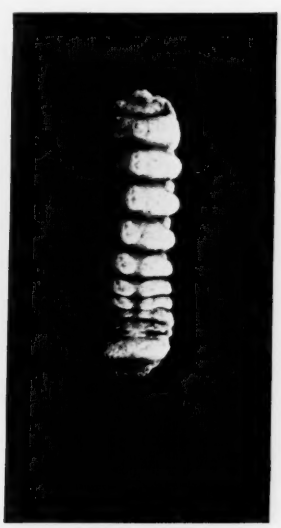

FIGURE 528.
Pupa, ventral view × 2.

FIGURE 531.
Imago × 2.

From photographs by *Hugh Main.*

The larvae are to be found in the stouter twigs of the willow and are nearly full grown in March or April; they pupate in May, and the beetles emerge in August.

THE MUSK BEETLE (*AROMIA MOSCHATA* LINNÉ.)

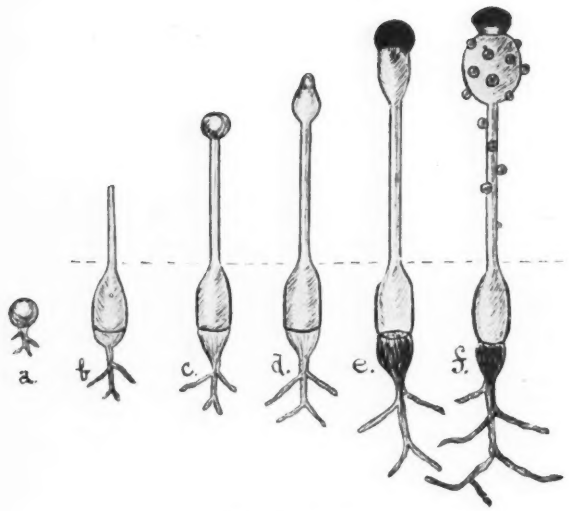

FIGURE 532.

a. b and c. Early stages of growth when the fungus is still yellow.

d. The fungus filled with a colourless liquid.

e. The partial formation of the sporangium.

f. A mature specimen studded with beads of moisture.

The portion below the dotted line is usually hidden below the surface of the soil.

FIGURE 533.

The collapse of the tissues after the explosion.

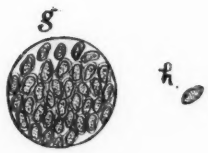

FIGURE 534.

g. Sporangium, highly magnified, with a number of spores still adhering to the inner surface.

h. A single spore magnified about 800 diameters.

Stages in the life history of *Pilobolus crystallinus*.

(See page 453.)

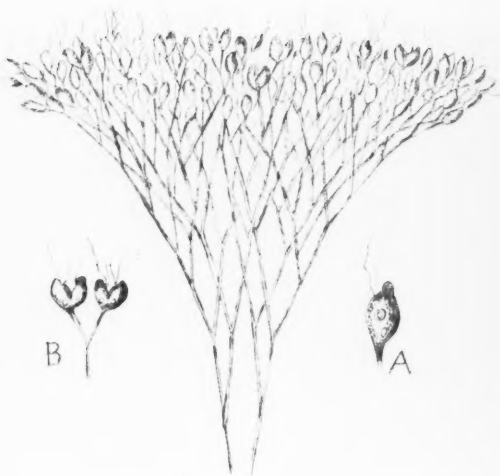

FIGURE 535.

Dendromonas virgaria Weisse (after Kent).

a. An isolated monad, highly magnified.

b. A colony of two monads in process of longitudinal division.

(See page 466.)

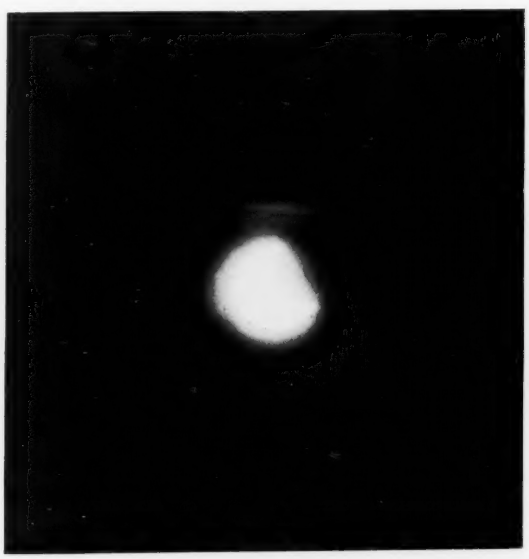

FIGURE 536.

The partial eclipse of the Sun, 1913, September 29th.

From a photograph taken with a telephoto lens at the Union Observatory, Johannesburg, South Africa, by Mrs. H. E. Wood.

(See page 459.)

AN EXPLOSIVE FUNGUS.

By P. J. ALEXANDER.

AMONG the various kinds of British fungi none, to my mind, are more interesting than those which, when mature, explode like a gun, shooting their spores several feet into the air. Some of these "ball-throwing" fungi belong to the Mucoraceae, a family of the true moulds (Phycomycetae).

The easiest type of this class to find, and the one that presents the greatest facilities for study (as most of its movements can be watched with the naked eye), is *Pilobolus crystallinus*. It may be found in spring, summer, and autumn growing in close clusters on all mammal dung, and especially on that of horses, cows, pigs, and sheep. I have likewise met with it on the droppings of birds. It first came to my notice quite by accident. One day, in my country rambles, I observed some small red pezizas on the sweepings from a sheep pen, and I took some home with me in a tin box that I always carry with me on such occasions. The next morning on going to examine my find I was astounded and delighted to see dense numbers of crystalline bulbs surmounted by a black cap and interspersed with tubes of a beautiful golden colour. I kept the medium on which they were growing moist, and examined the development of this new fungus for ten consecutive days, and I think the results of my observations and study may prove interesting to readers of "KNOWLEDGE."

History.—This fungus was apparently unknown a hundred and fifty years ago—at least we find no mention of it in any literature prior to that date. Scopoli was the first to call attention to it under the synonym of *Mucor obliquus* in 1772; but it was Wiggers who first enabled botanists to recognise this fungus by his description of it published in 1780. It is a curious fact that Tode, whose name is usually connected with this species, did not study it till four years later. We come across it, it is true, in a French work by Léveillé and Durieu de Maisonneuve in 1826; but they did little to elucidate a knowledge of this fungus, as many of their observations were erroneous. F. Cohn noticed it in 1851, and Francis Currey further investigated its formation in 1857. Two years later a Belgian botanist and a native of Louvain published his famous monograph on the subject, showing that he had made a complete analysis of this particular fungus, though still leaving one or two questions unsolved.

Growth.—The first sign of this fungus on the surface of the dung is a tiny golden speck, which, however, soon becomes elongated and shoots up in a golden finger-like tube. About three hours later this tube swells out at the top into a small globe (see Figure 532 *a*, *b*, *c*). Soon after this it loses its colour, the tube and bulb become crystalline, and a black hemispherical cap is formed on the top of the bulb. This cap is the sporangium containing the spores or reproductive bodies. At first it does not seem very distinct from the rest of the bulb (see Figure 532 *e*), but little by little a clear line of demarcation becomes visible (see Figure 532 *f*). The *Pilobolus* is now reaching maturity and ready to discharge its spores. It is filled with a transparent liquid which is slightly acid. Beads of moisture often form along the stem and hang like pearls around the bulb, giving the fully developed fungus a most beautiful and delicate appearance (see Figure 532 *f*). We can even observe with an ordinary lens small worm-like animalcules moving in the swollen bulb. It is now time to collect the spore. The best way to do this is to hold a piece of white paper a few inches over the black capsules. If the light is good the tension soon becomes too great and the caps are blown off with great force. They are sometimes thrown to a height of three feet. Before alighting on the paper they turn a somersault in the air, so as not to strike the surface with their convex side, but fall on the paper like an inverted cup, shutting up the spores inside. This black cap is made of a remarkably tough membrane as we soon discovered in making a microscopic preparation of the same (see Figure 534 *g*, which shows this sporangium, about six hundred times enlarged, full of yellow spores, ellipsoidal in shape). If the fungus is not allowed sufficient light, or if the atmosphere be too warm, instead of projecting the sporangium, the whole fungus withers and topples over (see Figure 533), and soon nothing is seen but a whitish powder left by the dried-up skin of the stem.

The whole plant grows, develops, and dies within twenty-four hours. If left out in the open in its natural surroundings it attains maturity and explodes shortly after sunrise; but if kept in a room where there is little or no sunlight the explosion does not take place until midday or later, and sometimes not at all. This would seem to show that not only elasticity of the tissues but also light is a great factor in causing the projection of the spores, which has been variously attributed by different writers to divers other causes, and erroneously to the tension caused by the liquid in the stem. But if this were the case, then heat would favour the explosion, causing expansion; but experience shows that it is just the contrary which occurs.

The natural size of this little fungus is about three millimetres; hence it will be found rather tiring to examine with the naked eye, but with a good magnifying glass, giving eight or ten diameters, one can study all its movements with ease and comfort.

One must be careful not to confound it with an allied species, *Pilobolus oedipus*, which it closely resembles, and which may be found in the mud and slime of gutters; but in this latter species the spores are globular and of a larger diameter than those of *Pilobolus crystallinus*.

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THE DEITIES OF ANCIENT MAORILAND.

By R. W. REID,

New Zealand.

THE perusal of books of travel, and of missionary registers dealing with New Zealand about a hundred years ago, provides the principal information the world possesses concerning the old-time Maoris, their habits and customs, and their religious beliefs. No worthy effort seems to have been made to collate the invaluable accounts of ancient Maoriland scattered through the kind of works mentioned. Here and there, in some old and faded missionary register, scientific facts of the greatest interest and importance are met with; nor are they of less moment because the writers did not always realise their importance, or foresee the avidity with which their somewhat artless contributions would be read by succeeding generations. One has to skim numerous heavy tomes—heavy in more senses than one—to arrive at anything approaching clear conceptions with respect to the religious beliefs—the superstitions, some may designate them—of the Maoris when they were first discovered by Europeans.

The Maoris, like the Greeks, Romans, and other races, had a great variety of gods. Atua was, however, their principal deity. Crozet, in his "Nouveau Voyage à la Mer du Sud," mentions that the Maoris with whom he came in contact had a number of subordinate divinities to whom they were wont to pray for victory over their enemies. A writer (unnamed) in the *Missionary Register* for 1822 gives a description of the Maoris' daily adoration of the sun, moon, and stars. Of the heavenly host the moon, he says, was their favourite. This statement seems to be not fully borne out by the writer; for he observed that when addressing the moon the Maoris employed a mournful song and appeared to be as full of apprehension as of devotion. They presented a totally different demeanour when engaged in their adoration of the sun. Then their arms were extended and partly uplifted, and though their heads were bowed "there was an appearance of much joy in their countenances." The songs sung in their worship, or adoration, of the sun were never solemn, as they were when the moon was addressed, but bright and cheerful. The old Maoris, in addition, held many strange ideas with regard to some of the more conspicuous constellations. Not only were the issues of human affairs influenced, but also the future was indicated by the movements of the stars. The Pleiads, shining in the deep blue of the New Zealand sky, touched the imaginations of the Maoris. Tennyson said the Pleiads

Glitter like a swarm of fire-flies tangled in a silver braid.

But the Maoris discerned there the presence of their kinsmen. The Pleiads, according to Nicholas's "Voyage to New Zealand," they believed to be seven of their departed countrymen fixed in the firmament. One eye only of each of those transported Maoris was visible, and in the form of a star. But it was a common superstition among them—and this fact is frequently mentioned in century-old records—that after death the left eyes of chiefs became stars.

The belief that the stars are the departed heroes of the earth, as readers are aware, is old and widespread. Traces of it can be found in the primitive faiths of nearly every land. A shooting star was regarded as an omen of ill, as generally a warning of the approaching death of a chief; and the Maoris, like the rest of us, have their own man in the moon. He, however, seems to be a kind of deity. He is immortal, and possesses the power of conferring immortality. He loved Rona, a Maori maiden, and, as she loved him in return, she accompanied him to the moon. Different versions of Rona's life after her translation to the night luminary are met with. One is that Rona remained in the moon, and another that she returned to earth to rejoin her Maori lover.

Atua, as stated, was the most powerful god in ancient Maoriland. The word Atua is found in several forms in most of the South Sea dialects, and is thought by some to be allied with the Sanscrit Dewa, the Greek Zeus, and the Latin Deus. This god was deemed by the Maoris to be immortal, omnipresent, invisible, and supreme. Yet, in spite of those mighty attributes, he was believed to be, in disposition, merely a vindictive and malignant demon. The *Missionary Register* for 1823 mentions that when a white clergyman spoke to the Maoris about the infinite goodness of God they bluntly responded with the query: "Are you joking with us?" They believed when anyone became sick, the illness was caused by Atua, in the form of a lizard, having gained admittance into the interior of the ailing person, preying upon his, or her, entrails. Then the *tohungas*, or priests, set to work. *The Proceedings of the Church Missionary Society* for 1819 describes the old Maori mode of frightening, or attempting to frighten, the demon god. The *tohungas*, willingly assisted by the common people, "addressed the most horrid imprecations and curses to the invisible cannibal, in the hope of thereby frightening him away." They imagined that, at other times, Atua amused himself by entangling

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the fishermen's nets and upsetting their canoes.

In the *Missionary Register* for 1823 is mentioned a circumstance which helps to throw light on the occasional ferocious attacks upon white explorers and others made by the Maoris. Probably the most notable, as it was among the first, of what appear to have been either sudden acts of frenzy or of cold, calculated massacre, was the slaughter of Captain Marion du Fresne at the Bay of Islands in 1772. Captain du Fresne, in command of the ship "Marquis de Castres," and Lieutenant Crozet, commanding the sloop "Mascarin," put into the Bay of Islands to refit. Friendly relations were soon established between the Frenchmen and the Maoris, and for several weeks both races lived together in harmony. "The inhabitants treated us with every show of friendship for thirty-three days," records Crozet in the volume already mentioned, "with the intention of eating us on the thirty-fourth." Whether the massacre was premeditated for a month or more, or was suddenly resorted to in a fit of religious excitement, has never been satisfactorily decided. The fact, however, remains that the Maoris suddenly attacked the party, killing, and afterwards eating, twenty-nine of the number, including du Fresne. Crozet had a narrow escape from the same fate, but he eluded the savages and "lived to tell the tale." The probability is that the murder of du Fresne and his twenty-eight countrymen was due to what in these later days would be designated religious mania. The *Register* says: "The natives have long suspected, ever since white men arrived in their country, that their great god Atua has been very angry with them for having allowed any white men to obtain a footing in their country, a proof of which they think they see in the greater mortality that has recently prevailed among them."

The *Missionary Register* four years later is found discussing these suspicions of the Maoris. It was then apparent that they attributed their losses, sickness, deaths—all their misfortunes—to the God of the Christians. Him they denounced accordingly as being cruel—at all events to others than Christians. The article proceeds: "Sometimes they more rationally assign as the cause of the many deaths the diseases that have been introduced among them by the whites. Until the whites came to their country, they say, young people did not die, but all lived to be so old as to be obliged to creep on their hands and knees." Missionaries and teachers tried to get the Maoris to believe that "the white man's God" and Atua were one and the same. The Rev. Samuel Marsden, New Zealand's first missionary, in one of his letters relates a conversation he had upon this theme with some Maoris, the sons of a chief, who had accompanied him to New South Wales. When he told them that there was but one God, they put the question: "Has the pakeha's [white man's] God given the pakehas any kumeras [sweet potatoes]?" They failed to understand why one God should give the Maoris kumeras and the white man none; and why, also, He should be partial to the whites in the matter of cattle, sheep, and horses and entirely neglect the Maoris so far as these animals were concerned. But the final, and to the Maoris the unanswerable, argument was: "If one God made us both, He would not have committed such a mistake as to give us different colours—make one black, the other white." Mr. Marsden, who, by the way, settled in New Zealand in 1814, asked a Maori what he conceived the Atua to be, and was answered: "The Atua is an immortal shadow."

In "Nicholas's Voyage" appears, on the authority, it is stated, of Nicholas's friend, Duaterra, a lengthy and fairly precise account of the inferior deities of the ancient Maoris. Their number was "very great" and "each has his distinct powers and functions." One minor god "was placed over the elements, another over the fowls and fishes, and so of the rest." Deifications of the different passions and affections also found a place in Maori mythology; a fact which suggests a connection of some kind with the early peoples of Europe and Egypt. It is very remarkable, as Nicholas points out, that the Maoris attributed the creation of man to their three principal deities acting together, "thus exhibiting in their barbarous theology something like a shadow of the Christian Trinity." Still more wonderful was their tradition respecting the creation or formation of the first woman, who, they said, was made of one of the man's ribs. Moreover, the Maori's general term for bone is pronounced something like *hevee*, which certainly seems to be not far removed from the Eve of Biblical narrative.

Chiefs of high standing had, according to Nicholas, their own particular god or gods. When, for instance, the ship "Active" was lying in the river Thames, in the North Island, there was a gale of wind, and this the natives on board attributed to the anger of Hupa's god. Hupa was a chief who lived near the Thames. An elderly native, a man of some note apparently, Koro-Koro by name, informed the master of the ship that, as soon as he got ashore, he would endeavour to prevail upon the chief to propitiate the offended deity. When Mr. Marsden, trying to embarrass the Maoris of Kiapara, asked them if they had ever seen or heard, or had any communication with, the god of that locality—for certain localities had their own particular god—he was bravely informed that the god of the Kiapara had been often heard whistling. Frequently chiefs were called Atuas, or gods, even while they were alive. There was, it will be observed, considerable confusion as to Atua. Atua was the principal god; but the name was thus also applied to men not thought to be specially endowed with supernatural power apparently, but to those who considered themselves as the habitation of deities. An aged chief, Terra by name, who is mentioned in the nineteenth report of the Church Missionary Society, solemnly assured a missionary that the god of thunder resided

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in his forehead. Not to be eclipsed by this kind of fame his neighbours, Shungie and Okeda, firmly maintained, against all critics and sceptics, that in them lived the gods of the sea.

The dwelling-place of the gods—they, like the Maoris, lived largely in community, it would appear—was always represented as being extremely beautiful. "When the clouds are tinted with bright and lively colours," writes Mr. Kendal, a missionary, "the Atua above, it is supposed, is planting sweet potatoes. At the season when these are planted in the ground the planters dress themselves in their best raiment, and say that, as Atuas on earth, they are imitating the Atua in heaven." Captain Cruise, in his journal, is responsible for the statement that the Maoris he met with a hundred years ago believed that the higher orders among them were immortal, but that when the common people died they perished for ever. The spirit, they explained, left the body the third day after death, till which time it hovered near the corpse, hearing quite well all that was said to it. But they held, further—and here again their beliefs become somewhat complicated and contradictory—that there was a separate immortality for each of the eyes of the dead chief. The left ascended to heaven and became a star, and the other, as a spirit, took flight for the Reinga. The Reinga is, nowadays, sometimes mentioned as the Elysium of the departed, and is also given to the rock on the north shore of New Zealand from which the Maoris believed the spirits leaped into the sea on their way to this Elysium. Little difficulty, apparently, was experienced in passing from the surface of the ocean to the portals of these happy regions. In most mythologies the way to spirit land is usually depicted as being long and painful. Southey, in his "Songs of the American Indians," for example, describes the dread path which has to be trod by the Hurons:

> To the country of the dead,
> Long and painful is thy way!
> O'er rivers wide and deep
> Lies the road that must be passed,
> By bridges narrow-wall'd,
> When scarce the soul can force its way,
> While the loose fabric totters under it.

War remained one of the chief employments in the olden-time Maori heaven, though how results were established in the matter of deaths and victories does not appear. A Wesleyan missionary, in *The Missionary Register* for 1826, relates a lively conversation which took place between him and several Maoris on the twin subjects of heaven and hell. He says: "On telling them about the two eternal states, as described in the Scriptures, one of the number, an old chief, began to protest against these things with all the vehemence imaginable, and said he assuredly would not go to heaven, nor would he go to hell to have nothing but fire to eat, but he would go to the Raing or Po, to eat kumeras with his friends who had gone before." Slaves were sacrificed on the death of a chief, so that they might accompany his spirit, or spirits. *The Missionary Register* for 1828 narrates the story of a child having been drowned, when the mother insisted upon a female slave being killed "to be a companion for it on its way to the Reinga." It only remains to add that these old beliefs are not yet wholly extinct in New Zealand. The present-day Maoris will seldom venture far from their homes when the night is dark—spirits are then abroad. Graveyards and the houses of dead chiefs are *tapu*; to desecrate them would bring affliction, possibly death. Still, in the silence of night, when the cry of a belated bird is heard out of the darkness, the Maori will exclaim: "Ah! there goes another spirit to Te Reinga."

THE LATE ALFRED RUSSEL WALLACE.

As our frontispiece to the volume of "KNOWLEDGE" for 1912 we gave a portrait of Sir Joseph Hooker, whom science had recently lost, and who in the year 1858, with Sir Charles Lyell, shared the honour of communicating to the Linnean Society the papers relating to the production of varieties, races, and species which contained "the results of the investigations of two indefatigable naturalists, Mr. Charles Darwin and Mr. Alfred Wallace."

Hooker died at the age of ninety-four and now we choose as our frontispiece a portrait of Dr. Alfred Russel Wallace, who has just passed away at the age of ninety. The part which Wallace played in the establishment of the theory of natural selection is too well known to need any comment from us, but we may remind our readers of one or two points in his life. He was born at Usk in Monmouthshire, on January 8th, 1823, and was eight years younger than Darwin. He left Hertford Grammar School in 1836, and helped his brother who was an architect and surveyor. In 1840 he began to take an interest in natural history and travel, and while he was a master at a school in Leicester he met Mr. H. W. Bates and took up with him the study of beetles. It was with Bates that Wallace started off in 1848 to the Amazons, to gather facts towards solving the problem of the origin of species.

In 1852 Wallace, who had left Bates a year or so previously, returned to England, losing all his collections owing to his ship being burnt, and spending ten days in an open boat. He remained in England for a year and a half to publish a book on his travels, after which he went to the Malay Archipelago for nearly eight years. In February, 1858, while he was in the Moluccas, he got the first idea of the survival of the fittest obtaining as did Darwin a suggestion from Malthus's "Essay on Population." The paper arising out of this, Wallace sent to Darwin. It is well known that with regard to some points Wallace differed from Darwin, and he occupied himself in the later years of his life with other matters than those which are purely scientific, but into these we need not here go.

THE FACE OF THE SKY FOR JANUARY.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

TABLE 87.

Date.	Sun. R.A.	Sun. Dec.	Moon. R.A.	Moon. Dec.	Mercury. R.A.	Mercury. Dec.	Venus. R.A.	Venus. Dec.	Mars. R.A.	Mars. Dec.	Saturn. R.A.	Saturn. Dec.	Neptune. R.A.	Neptune. Dec.
Greenwich Noon.	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m	°	h. m.	°	h. m.	°
Jan. 1	18 44·6	S. 23·1	22 37·1	S. 9·7	17 44·7	S 23·8	18 1·5	S. 23·5	7 12·9	N. 26·3	4 46·0	N. 20·7	7 57·1	N. 20·3
,, 6	19 6·6	22·6	2 12·0	N. 17·4	18 18·1	24·3	18 28·9	23·5	7 4·1	26·6	4 44·6	20·6	7 56·5	20·3
,, 11	19 28·5	21·9	6 50·7	N. 27·6	18 52·3	24·3	18 56·3	23·4	6 55·5	26·9	4 43·4	20·6	7 55·9	20·3
,, 16	19 50·0	21·0	11 30·9	N. 2·5	19 27·1	23·7	19 23·5	22·7	6 47·4	27·1	4 42·3	20·6	7 55·3	20·4
,, 21	20 11·3	20·0	15 57·2	S. 25·6	20 2·4	22·5	19 50·5	21·8	6 40·3	27·2	4 41·4	20·6	7 54·7	20·4
,, 26	20 32·3	18·9	20 46·5	S. 21·2	20 37·8	20·7	20 17·0	20·7	6 34·4	27·2	4 40·6	20·6	7 54·2	20·4
,, 31	20 53·0	S. 17·5	0 29·3	N. 5·4	21 13·1	S. 18·2	20 43·1	S. 19·3	6 30·0	N. 27·2	4 40·1	N. 20·6	7 53·6	N. 20·4

TABLE 88.

Date.	Sun. P	Sun. B	Sun. L	Moon. P	Mars. P	Mars. B	Mars. L	Mars. T
Greenwich Noon.	°	°	°	°	°	°	°	h. m.
Jan. 1	+ 2·1	−3·1	228·6	−20·4	−16·6	+5·3	182·9	0 6 *m**
,, 6	− 0·3	3·7	162·8	−18·5	17·7	4·4	139·2	2 29 *m*
,, 11	2·7	4·2	96·9	+ 4·4	18·8	3·6	95·4	5 29 *m*
,, 16	5·1	4·8	31·1	+21·7	19·8	2·8	51·4	8 29 *m*
,, 21	7·4	5·2	325·3	+11·3	20·7	2·2	7·3	11 30 *m*
,, 26	9·6	5·6	259·4	−14·2	21·4	1·7	322·9	2 32 *e*
,, 31	+11·8	−6·0	193·6	−21·8	−21·9	+1·3	278·3	5 35 *e*

P is the position angle of the North end of the body's axis measured eastward from the North Point of the disc. B, L are the helio-(planeto-)graphical latitude and longitude of the centre of the disc. In the case of Mars, T is the time of passage of Fastigium Aryn across the centre of the disc.

The letters *m*, *e*, stand for morning, evening. The day is taken as beginning at midnight.

The asterisk indicates the day following that given in the date column.

THE SUN begins its Northward March. Nearest Earth $3^d\ 9^h$ *e*. Its semi-diameter diminishes from 16′ 17½″ to 16′ 15½″. Sunrise changes from $8^h\ 8^m$ to $7^h\ 44^m$; sunset from $3^h\ 58^m$ to $4^h\ 43^m$.

MERCURY is a morning star till 25th, but too near the Sun for convenient observation. Semi-diameter 2½″. Illumination nearly full. In "Face of Sky for December" read "Mercury is a morning Star," not "evening."

VENUS is a morning star, but getting too near the Sun for convenient observation. Disc practically full. Semi-diameter 5″. One degree N. of Mercury, January $14^d\ 5^h$ *m*. Superior conjunction, February 11th.

TABLE 89. Occultations of stars by the Moon visible at Greenwich.

Date.	Star's Name.	Magnitude.	Disappearance. Mean Time.	Disappearance. Angle from N. to E.	Reappearance. Mean Time.	Reappearance. Angle from N. to E.
1914.			h. m.		h. m.	
Jan. 2 ...	Wash. 1574	7·0	4 50 *e*	13°	—	—°
,, 4 ..	Wash. 56	6·7	8 48 *e*	29	—	—
,, 6 ...	Wash. 149	6·8	8 15 *e*	79	—	—
,, 9 ...	BAC 1648	6·4	10 16 *e*	64	11 27 *e*	291
,, 10 ...	BAC 1746	6·5	5 10 *m*	92	6 0 *m*	277
,, 11 ...	BD+27°1164	6·9	4 57 *m*	90	—	—
,, 12 ...	κ Geminorum	3·6	7 45 *m*	136	8 25 *m*	256
,, 12 ...	BD+23°1913	6·4	5 18 *e*	98	6 12 *e*	280
,, 13 ...	Wash. 635	6·6	—	—	9 14 *e*	210
,, 15 ...	BD+11°2217	7·0	—	—	3 34 *m*	303
,, 15 ...	45 Leonis	5·8	5 0 *m*	174	5 42 *m*	256
,, 15 ...	ρ Leonis	3·8	7 22 *m*	97	8 13 *m*	324
,, 16 ...	BAC 4054	6.4	10 31 *e*	100	11 25 *e*	322
,, 17 ...	Wash. 789	6·9	—	—	6 7 *m*	299
,, 20 ...	BAC 4867	6·4	2 36 *m*	98	3 35 *m*	321
,, 20 ...	BAC 4879	6·1	3 7 *m*	102	4 11 *m*	318
,, 31 ...	62 Piscium	6·1	9 1 *e*	92	9 55 *e*	217
,, 31 ...	δ Piscium	4·6	9 27 *e*	41	10 21 *e*	269

From New to Full the disappearances occur at the Dark Limb, from Full to New the reappearances.

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THE MOON.—First Quarter $4^d\ 1^h\ 9^m\ e$; Full $12^d\ 5^h\ 9^m\ m$; Last Quarter $19^d\ 0^h\ 30^m\ m$. New $26^d\ 6^h\ 34^m\ m$. Apogee $3^d\ 9^h\ e$. Perigee $15^d\ 6^h\ e$. Apogee $31^d\ 5^h\ e$, semi-diameter 14′ 48″, 16′ 17″, 14′ 47″ respectively. Maximum Librations, 9^d 6° E, 9^d 7° S, 22^d 7° N, 23^d 5° W. The letters indicate the region of the Moon's limb brought into view by libration. E. W. are with reference to our sky, not as they would appear to an observer on the Moon. (See Table 89.)

MARS is in opposition $5^d\ 6^h\ e$. Nearest Earth on 1st, distance 0·622. This is an unfavourable opposition as regards distance, but favourable as regards planet's declination. It will be seen that both hemispheres of Mars are observable, but the Northern one is best placed. The semi-diameter during January, diminishes from 7½″ to 6½″. The unilluminated lune is on the East: its width increases from 0 to $\frac{4}{10}$″. The Planet is in Gemini: 2° N. of ϵ, on 22nd.

JUPITER is invisible, being in conjunction with the Sun on 20th.

SATURN is very well placed for observation, having been in opposition on Dec. 7th. Polar semi-diameter 9½″. P. is −4°·2; B−26°·7. Ring major axis 47″, minor 21″. The ring is approaching its maximum opening, and projects beyond the poles of the planet. It is interesting to measure the exact amount of overlap. The absolute maximum opening will occur on July 1st, but the Planet will then be too near the Sun to see.

East Elongations of Tethys (every fourth given), $2^d\ 0^h{\cdot}0e$, $10^d\ 1^h{\cdot}2m$, $17^d\ 2^h{\cdot}4e$, $25^d\ 3^h{\cdot}6m$; Dione (every third given), $2^d\ 2^h{\cdot}7e$, $10^d\ 7^h{\cdot}8e$, $19^d\ 0^h{\cdot}7m$, $27^d\ 5^h{\cdot}7m$; Rhea (every second given), $2^d\ 2^h{\cdot}8m$, $11^d\ 3^h{\cdot}5m$, $20^d\ 4^h{\cdot}3m$, $29^d\ 5^h{\cdot}0m$. For Titan and Iapetus E.W. mean East and West Elongations; I. Inferior (North) Conjunctions, S. Superior (South) ones. Titan, $5^d\ 6^h{\cdot}2m$ I.; $9^d\ 2^h{\cdot}6m$ W., $13^d\ 1^h{\cdot}9m$ S., $17^d\ 4^h{\cdot}6m$ E., $21^d\ 4^h{\cdot}2m$ I., $25^d\ 0^h{\cdot}6m$ W., $28^d\ 12^h{\cdot}0e$ S; Iapetus, $6^d\ 1^h{\cdot}9e$ I., $25^d\ 1^h{\cdot}4e$ W.

URANUS is invisible, being in conjunction with the Sun on 28th.

NEPTUNE is in opposition on the 17th. Semi-diameter 1″. Possessors of small telescopes may easily recognise it by its motion, if they make a sketch map of the stars in the region, and observe it night by night.

WESTPHAL'S COMET.—See the ephemeris given last month. The R.A. will be some 20″ greater than the ephemeris value, the declination ½° less.

METEOR SHOWERS (from Mr. Denning's List):—

Date.	Radiant. R.A.	Radiant. Dec.	Remarks.
Jan. 2-3 ...	230°	+ 53°	Brilliant shower, swift, long paths.
,, 3 ..	156	+ 41	Swift.
,, 11-25 ...	220	+ 13	Swift, streaks.
,, 17 ...	295	+ 53	Slow, bright.
,, 17-23 ..	159	+ 27	Swift.
,, 25 ...	131	+ 32	Swift.
,, 29 ...	213	+ 52	Very swift.

DOUBLE STARS AND CLUSTERS.—The tables of these given two years ago are again available, and readers are referred to the corresponding month of two years ago.

VARIABLE STARS.—The list will be restricted to two hours of Right Ascension each month. The stars given in recent months continue to be observable.

TABLE 90. NON-ALGOL STARS.

Star.	Right Ascension. h. m.	Declination. °	Magnitudes.	Period. d.	Date of Maximum.
X Aurigae	6 6	+50·2	8·1 to 13·0	162·6	Feb. 4.
η Geminorum	6 10	+22·5	3·3 to 4·2	233	About January.
V Aurigae	6 18	+47·8	8·3 to 11·7	352	Dec. 22.
V Monocerotis	6 18	− 2·1	7·7 to 10·2	332	Jan. 7.
V Lyncis	6 22	+61·4	8·6 to 9·4	72	Feb. 1.
R Lyncis	6 54	+55·5	6·5 to 14·0	379·2	Mar. 27.
S Canis Min....	7 28	+ 8·5	7·7 to 12·7	330·3	Dec. 21.
Y Geminorum	7 36	+20·7	8·5 to 9·2	286	Jan. 27.
S Geminorum	7 38	+23·7	8·3 to 14·5	293·8	Feb. 4.
U Puppis	7 57	−12·6	8·5 to 14·5	315	Dec. 16.

Principal Minima of β Lyrae Jan. $12^d\ 7^h\ m$, $25^d\ 5^h\ m$. Period $12^d\ 21^h{\cdot}8$.

Algol minima Jan. $7^d\ 4^h\ 5^m m$, $10^d\ 0^h\ 54^m m$, $12^d\ 9^h\ 42^m e$, $15^d\ 6^h\ 31^m e$, $18^d\ 3^h\ 20^m e$, $30^d\ 2^h\ 36^m m$.

Mira Ceti will reach maximum in March.

CORRESPONDENCE.

THE FLOWERING OF PLANTS IN SOUTH GERMANY IN 1911 AND 1913.

To the Editors of "KNOWLEDGE."

SIRS,—Everyone knows the delights of botanists who, in the month of August, have wandered through the Austrian and Italian Tyrol. Edelweiss and Alpine roses form only a small part of the treasures which they bring away, and they never forget the fragrance of those Alpine meadows where the flowers bloom and the bees fertilise them close under the ice and snow. What is not generally realised is the wealth of the Odenwald and the Schwarzwald especially so far as the fungi are concerned, and these have been particularly abundant in damp years, like 1912 and 1913. Unfortunately the orchards and gardens have neither been so profitable nor so interesting.

So far as the plant-world of South Germany is concerned, the *annus mirabilis* was the year 1911. The vineyards were of more importance than the orchards. The grapes were small but as sweet as sugar, and the tourist now in the

neighbourhood of Rüdesheim and Eltville may deem himself fortunate if the kindly host, who has his own vineyard, will supply him with the vintage of 1911. To mix it with Apollinaris, or any natural water, would be a crime.

The Spanish fruiterers, of whom there are many in this part of Germany, had no need to import any fruit except real exotics such as *aubergines* and *pimïentos*. Quinces and medlars were relatively extremely abundant. Peaches and apricots were not only thoroughly ripe but also abundant, and consequently so cheap that in some places they were allowed to drop and rot upon the ground. It was worth a walk of many miles out of the tourist's route to see in the neighbourhood of Heilbronn the patient oxen drawing wagon-loads of pumpkins which were like great balls of gold.

In Heidelberg and other towns of Baden it is extremely common to see oleanders and pomegranates in public and private gardens. They are often arranged in rows in front of fashionable hotels, and now and again even in front of a railway station. The blossoms on these were as profuse and as beautiful as those I have seen in the warmest parts of the South of Spain. Autumn blossoms, too, on the magnolias were frequently seen, but this I find is not so rare. What surprised me most was an avenue of horse-chestnuts from which all the leaves had fallen, but the trees were covered with recently opened blossoms. Again and again have I seen horse-chestnuts, from which the leaves had fallen, covered with new leaves, as though it were spring-time; but here were masses of blossom covering trees which were otherwise bare. Is all this a development of buds recently formed, or a development of the dormant buds of a previous year?

This year has been worse than 1912, for the July of that year was a warm month, whereas the heat this year has come much too late. One peculiarity of the Neckar Valley is the occurrence during the first fortnight of August of multitudes of Ephemeridae, which are known there as *August-Fliegen* or *Weisse-Fliegen*. Sometimes these are so abundant as to fill the street lamps, and they are swept from the pavement in barrow-loads, to be used afterwards as bait for fishing in the Neckar. This year the little *white flies* have never been seen. The pomegranates and oleanders have not blossomed, the grapes are not sugar-sweet, and apricots and some other fruits will never ripen. The fruiterers must import what they want from Spain or the South of France, or depend in part upon fruits which have been ripened under glass.

One thing which I have just seen is worth mentioning. Not far from the dusty road which runs parallel to the Neckar between Hirschhorn and Eberbach there is an apple-tree in full blossom. Now what is the cause of that? Certainly not the warmth of the season. It is not the sun which has wooed those blossoms from the buds. What one would like to know is, what buds have been developed, and what will, in all probability, be the history of that tree in the near future?

E. J. DUNGATE.

76, NEUENHEIMER LANDSTRASSE,
HEIDELBERG.

FRESH WORLDS TO CONQUER.

To the Editors of "KNOWLEDGE."

SIRS,—The other day when reading a scientific work (Mr. Soddy's excellent little book on Matter and Energy) I came across the expression, "There is no fear that Science will yet awhile be sighing, like Alexander, for fresh worlds to conquer." I am happy to believe that this is true of Science; but I strongly object to having such a worse than childish aspiration put into the mouth of one of the most highly educated heroes this earth has ever seen. No doubt hundreds have said the same thing before Mr. Soddy, and hundreds will say it again. But no amount of repetition will make the phrase other than what it is, namely, not only false, but the very reverse of what is true, a piece of arrant nonsense and an insult to the memory of a great man, who certainly had his faults, but who never could have accomplished such wonders had his hold on the reality of things been less steadfast and complete. And precisely the fact that so eminent an authority as Mr. Soddy should repeat the absurdity shows that the time for correcting it has arrived.

Alexander did not conquer this world, and was perfectly aware that he had not done so by a long way. It was with bitter grief that he turned back from his Indian expedition in deference to the remonstrances of his army. He must have known, like every other Greek, that the Adriatic limited his power to the West, that Italy, Sicily, and Carthage still remained unsubdued, that his fleets had not doubled the southern cape of Africa, long known to be circumnavigable, nor even sailed to the Pillars of Hercules. And the interesting thing, not merely for his biographers, but for the history of science, is to read the true story which has been converted by an almost inconceivable blunder into the false story commonly circulated.

The true story runs as follows in the version given by Plutarch:

"When Alexander heard from Anaxarchus [a philosopher from Abdêra] that there were an infinity of worlds, he burst into tears, and on being asked what ailed him replied, 'Is it not deplorable that while there are infinite worlds we should not yet have made ourselves masters of this one world?'"

Plutarch tells the story, not where we would expect it, in his Life of Alexander, but in his Moral Anecdotes, though what particular lesson we are expected to draw from it does not appear. Perhaps it was the same as that suggested to Tennyson, when after looking through a telescope at the great star-cluster in Perseus, he observed, "One doesn't think much of the county families after that." Anyhow, the interesting thing to find is that, contemporaneously with the strictly finite world of Aristotle, Alexander's own teacher, revolving concentrically round our Earth, and enclosed by the outermost solid star-sphere, conceived as a single body rotating once in about twenty-four hours, the older and much truer Ionian idea of infinite worlds should still have prevailed.

Thus by a path the reverse of Hamlet's we may follow in imagination the noble dust of Alexander, or at least of Alexander's table-talk, until it mingles with the star-dust of the Milky Way.

ALFRED W. BENN.

THE PARTIAL ECLIPSE OF THE SUN, 1913, SEPTEMBER 29.

To the Editors of "KNOWLEDGE."

SIRS,—This phenomenon* was observed at the Union Observatory, Johannesburg. At the time of sunrise a low-lying bank of heavy clouds extended along the Eastern horizon, but the sun began to appear above these clouds six minutes after the calculated time of sunrise. The first appearance of the sun was a very interesting sight. The eclipse was then about at its middle phase and the sun, as it rose above the cloud-bank, was exactly like a lion's claw. When the sun was clear of the clouds it was possible to trace the dark outline of the moon against a slightly lighter background for nearly a minute of arc beyond the sun. This projection of the moon was observed in the neighbourhood of both cusps of the sun. The observation was made with a three-inch refractor through a rather light dark glass. Definition throughout was too poor to enable irregularities on the edge of the moon to be seen. The last contact was observed at $16^h\ 32^m\ 50^s$ Greenwich time.

(Mrs.) H. E. WOOD.

UNION OBSERVATORY,
JOHANNESBURG,
SOUTH AFRICA.

* See Figure 536, page 452.

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SOLAR DISTURBANCES DURING OCTOBER, 1913.

By FRANK C. DENNETT.

OCTOBER has proved more interesting to the solar observer than any month since December last. Only one day was missed, October the 5th. On seven days (4, 9 to 11, 13, 21, and 30) the disc appeared free from disturbance, and on nine others (1 to 3, 14 to 18, 22 and 23,) only faculae were visible. It is to be remarked that the greater part of the faculae and the whole of the dark spots were displayed in the northern hemisphere. The longitude of the central meridian at noon on October 1st, was 1° 24′.

No. 12.—A pretty group of tiny pores first seen on the 6th, which in the afternoon were ranged like segments of two interlocking eclipses. On the 7th only the rear portion was seen, whilst on the 8th only a grey facula-lipped pore remained which was gone next day. Its maximum length was 35,000 miles.

No. 13.—Two pores, the larger preceding, almost in the centre of the disc, only seen on the 12th.

No. 14.—A small bright facula having two penumbraless pores, one on either side, east and west, seen on the 19th, when the disturbance showed hydrogen flocculi, and the dark D_3 line of helium with the spectroscope. Next day the facula was still traceable with minute pores but they were not seen after.

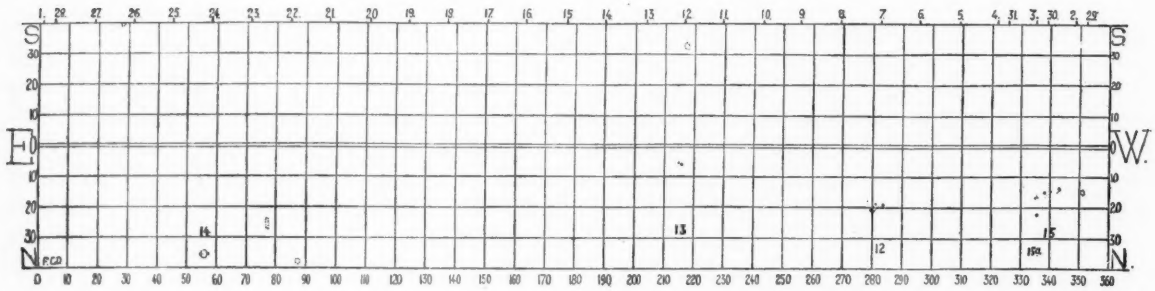
No. 15.—On the 24th a group of pores was visible a little within the north-eastern limb amid brilliant faculae. The components remained small, and were subject to much change until last seen on the 29th. Its greatest length was 72,000 miles.

No. 15A.—On the 31st there was a dark grey "veiled" spotlet a little north of the area which had been occupied by No. 15. It was not, however, seen afterwards.

Faculae like tiny bright granules were visible within a few degrees of the North Pole, on October 1st to 3rd, 6th, 15th, 16th, 24th and 25th. A small one was noted at longitude 28°, S. latitude 40°, on the 3rd. Faculae were also noted near the south-west limb on the 11th, and the north-east on the 14th. On the 16th a faculic knot was at longitude 217°, S. latitude 33°. On the 17th and 18th a faculic knot seen at 87°, 38° N. (near the north-east limb), and a bright streakiness near 77°, 25° N. Traces of the former still showed on the 20th, as well as a pale patch within the eastern limb a little north. Pale faculae a little within the eastern, and nearing the south-western limbs on the 22nd. Also within the north-eastern limb, at 351°, 15° N. on the 23rd and 24th. Within the eastern limb a faculic knot was visible on the 31st.

Our chart is constructed from the combined observations of Messrs. J. McHarg, A. A. Buss, C. Frooms, E. E. Peacock, and the writer.

DAY OF OCTOBER, 1913



NOTES.

ASTRONOMY.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

DETERMINATION OF RADIAL VELOCITIES OF FAINTER STARS.—It has often been felt that it would be of great importance in advancing our knowledge of the structure of the universe, if spectrograms taken with an objective prism could be used in the determination of radial velocities. The results with the slit spectroscope are splendid in their marvellous accuracy; but owing to the great loss of light at the slit, and the resulting length of exposure, the method is practically limited to the naked-eye stars, or those not much below this limit. When the method of the prism before the object glass, without any slit, is employed, there is no loss of light, consequently much fainter stars can be reached with a moderate exposure; also there are many spectra on each plate, so the work of making a spectroscopic Durchmüsterung is rendered possible. In fact, much progress has been made with this at Harvard, but hitherto attention has been paid merely to the type of spectrum, not to motion in the line of sight. Suggested methods of doing this were given by Professor Pickering and others; these are now discussed by Dr. Schlesinger in *Proc. Amer. Phil. Soc.*, Vol. LII, No. 209. He considers two methods practicable for obtaining fairly accurate results. The first consists in measuring the distance between two known lines in each spectrum. With prismatic spectra the effect of velocity in the line of sight is much greater for the violet end of the spectrum than for the red. Hence stars approaching us have their spectra lengthened, those receding have them shortened. Plates are now available that will photograph the red end of the spectrum with moderate exposures. It is desirable to use a Cooke Triple object-glass, or else to have one specially designed to bring the required regions into focus together. The author also recommends the use of a temperature case surrounding the whole apparatus, as change of temperature affects the sharpness of the spectra. He also advises taking check plates every night on stars whose velocity is already known by the slit method. With these precautions results of considerable accuracy may be expected.

The other practicable method is that of placing a screen of neodymium chloride before the plate. This artificially introduces some absorption lines into the spectrum, one of which, at λ 4272, is stated to be suitable as a comparison line.

He does not recommend this method except for stars of types A and B (Sirius and Orion). In solar and red stars the artificial line is confused with stellar lines.

He gives a third method, but as he considers it less hopeful I do not describe it.

In the case of object-glasses too large to cover by objective prisms, he suggests the use of an auxiliary lens, placed in the cone of rays from the objective, so as to give a smaller pencil of parallel light than that falling on the objective. In this way a smaller prism will suffice, without sacrificing any of the aperture.

It goes without saying that a less degree of accuracy is expected than with the slit method. But what is desired is not so much the exact motion of individual stars as averages for large groups of stars of different types, and distributed over the sky. For this purpose the new methods are full of promise.

COMETS.—In recent years, the autumn has been the great time for comets, and this year has been no exception; four comets, three of them periodic, have been under observation. Westphal's is the most important, from its association with Neptune. It presented an interesting appearance early in October, being easily visible in an opera glass (so that Mrs. F. Wilson found it without knowing of its previous discovery) and having been glimpsed with the unaided eye. However, it did not live up to this early promise. It grew faint and diffused, in spite of its approach to the Sun, and by the end of October was very difficult to see.

On October 22nd it passed within half a degree of Metcalf's comet, and the unusual spectacle was afforded of two comets in the same field. Both were then of the ninth magnitude. As Westphal's is not at perihelion till 3 p.m. on November 26th, it is quite likely that there may be another outburst of activity. This uncertainty about the physical behaviour of comets adds interest to their study. During December Westphal's will be about 40′ south of the ephemeris given last month; the R.A. will be a minute or more in excess of the ephemeris. Corrected elements by Miss Levy: Omega 56° 31′ 36″, Node 346° 47′ 45″, inclination 42° 33′ 7″, Period 61·121 years, Log. q. 0·1012, Log. a. 1·1908.

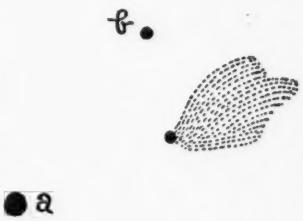


FIGURE 537.

Neujmin's Comet as sketched by Prof. Barnard. 1913, Sept. 9th. Star a is Nicolaiev 5064, mag. 8.3; b is of mag. 11.7; c, 11.4; comet, 11.5. The distance a-c is 4½′. South is at the top.

Neujmin's comet was interesting in two ways; first for its appearance. It was exactly like a small star with a faint nebulous appendage to the south-east. This stellar appearance enabled its position to be fixed with great accuracy. Herr Stracke has computed the following orbit. Perihelion, 1913, Aug. 16·31 Berlin, Omega 346° 7′ 52″, Node 357° 54′ 19″ inclination 14° 52′ 34″, eccentricity ·7786, Period 18·16 years; perihelion distance 1·5300, aphelion distance 12·288.

The comet appears to belong to the group that owns allegiance to Saturn. Two other members of the group are known. One is Tuttle's comet, the other was discovered by Peters in 1846, but has never been seen since. It is to be hoped that the period of the present comet will be accurately determined, to facilitate its recovery at its next return.

A comet discovered by Dr. Zinner at Bamberg, 1913 *e*, is identical with Giacobini's comet, 1900, III, the period being 6·465 years. Perihelion passage is 1913, November 2·30, Omega 171° 32′, Node 193° 0′, inclination 32° 17′ log. q. 9·9961. Owing to its rapid southerly motion it will soon be out of reach of European observers.

THE ANDROMEDA NEBULA.—Lowell Bulletin No. 58, contains an investigation by Mr. V. M. Slipher on the radial velocity of this nebula. It has been known for some years that there were some Fraunhofer lines in its faint continuous spectrum. He secured four plates last autumn and winter with exposures of about seven hours each, and obtains the startling result that the nebula is approaching us at the rate of 297 kilometres per second, the individual values being 284, 296, 308, 301. It is a little difficult to credit that such a vast object as this nebula (certainly several light-years in length) can be moving bodily with such inconceivable speed, and the results will doubtless be discussed by skilled spectroscopists, to see if there is any other explanation of the shifts of the lines. Mr. Slipher notes that the shift in the violet was twice that in the blue, which accords with the supposition that it is due to velocity. If it really has a speed of this order, its distance must be very great, or it would have a sensible proper motion; for the direction of motion is not likely to be exactly radial.

I have lately been examining the photographs of this nebula, and it appears to me that there are far more cases where curves of stars mark out and follow the shape of prominent portions of the nebula than we can reasonably attribute to chance. In my view these stars are actually associated with the nebula. If this assumption is true it is of twofold importance; first, it would dispose of the theory that the nebula is an external galaxy, for these stars are exactly like those forming the background of the sky in ordinary regions, and obviously belonging to our galaxy. Secondly, these stars could be examined for parallax and proper motion much more easily than the nebula itself, since its outlines are vague. The case of the Orion nebula may be recalled; Sir W. Huggins considered it established that the stars forming the Trapezium were actually, not merely optically, associated with the nebula, so that they could be examined for parallax and proper motion, instead of the nebula itself; the soundness of this view is generally admitted.

CAMPBELL'S "STELLAR MOTIONS," AND SIR DAVID GILL'S "HISTORY OF THE CAPE OBSERVATORY."—These two books have lately appeared. The first, which is the "Silliman Lectures, 1910" should be read by all who desire an intimate acquaintance with the marvellous precision of modern spectrographic work, especially as applied to motion in the line of sight, and the countless precautions that are taken to avoid systematic errors in the results. In our own system the method has been applied to various problems: the rotation of the Sun, Venus, and Uranus, and the optical verification of the fact that Saturn's ring is composed of small particles with independent motion. In the stellar heavens the method has given a new determination of the direction and speed of the Sun's motion; it has given great help in forming estimates of the distances of various classes of stars, and in demonstrating the unexpected fact that the speed of a star increases as its spectral type advances. Its application to the study of Algol variables and those of the Beta Lyrae, Cepheid and Geminid types, are also dealt with, and some interesting conclusions are drawn from statistics of spectroscopic doubles.

Sir David Gill gives a *résumé* of the important problems with which the Cape Observatory has been associated. The distances of the Sun, Moon, and Stars, Jupiter's satellites, The Cape Photographic Durchmüsterung, double stars, spectroscopic work, the survey of Africa, are all dealt with. I hope to give some further notes on this book in a future month, but in the meantime I recommend our readers to study it for themselves.

DISTRIBUTION OF CLUSTERS AND NEBULAE.—Dr. Charlier, of Lund, has published some statistics in tabular and graphical form of the distribution of clusters and nebulae in various regions of the sky: they are based on the three catalogues of Dreyer, containing 13,223 objects, of which 769 are clusters. The clusters show an unmistakable tendency to congregate along, or near, the Milky Way. This seems to show that most of the clusters are actually involved in the star-clouds of the Milky Way, and are consequently extremely distant. The individual stars may therefore be very much

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larger, and the degree of compression very much slighter, than we are apt to imagine from their telescopic aspect.

The nebulae, on the other hand, show a decided avoidance of the Milky Way and an aggregation towards its poles, especially the northern one in Coma Berenices. He has divided the nebulae into various classes according to size, shape, and brightness, but the same general arrangement persists. He has not grouped them according to spectral type (the distinction between "white" and "green" nebulae), though this difference is more significant than the others. It has been suggested that the paucity of nebulae along the galaxy arises from the brightness of the sky background, and the consequent difficulty of detecting faint nebulous objects. However, even the bright nebulae cluster very definitely round the Coma Berenices pole. There is no such marked aggregation of them at the opposite pole.

On the whole it looks as if the Galaxy had some influence on the distribution of nebulae; if so, the greater part of them belong to our own stellar system, and are not external universes. This is also supported by the comparatively small radial velocity indicated by those whose spectra have been carefully observed. We should expect independent universes to have considerable motion relatively to each other, and so to show large radial velocities. Those actually found are of the same order of magnitude as those of the stars.

BOTANY.

By PROFESSOR F. CAVERS, D.Sc., F.L.S

BOTANY AT THE BRITISH ASSOCIATION (*continued*).—Apart from the Presidential Address given by Miss Sargant, the only notable paper of wide interest was that by Professor Reinke, "On the Nature of Life." The veteran Kiel botanist protested against the view that life can be interpreted merely mechanically, and urged that the greater the progress in experimental physiology, the better we learn to use our knowledge of non-living matter for the explanation of the processes of life, the more we understand that a complete physico-chemical analysis is impossible for any important life process. Behind all the physico-chemical facts ascertained by physiological studies there hides an unknown factor, "an *x* not to be solved by levers and screws and chemical reägents." He maintained that although the laws of energy are valid in the organism as well as in unorganised nature, life being based on transformations of energy or "elementary processes," these processes are not thrown together without order in the living body, but are united by an invisible chain which maintains order among the elementary processes and represents the true difference between life and any event in lifeless nature. This "life principle" is, unlike the single elementary processes, inaccessible to physiological analysis; it is "no force or power, it is a principle of succession, of order, of regulation, of harmony."

An interesting "semi-popular address" was given by Professor W. H. Lang on epiphyllous plants—chiefly algae, lichens, and liverworts—which grow in a non-parasitic manner on the foliage of trees in very damp tropical forests. He pointed out the prevalence in such forms of an efficient means of attachment to the surface of the leaf, and laid stress upon the occurrence of flat disc-like early stages in the germination of the spores of epiphyllous liverworts as an adaptation to this mode of life.

Among various other contributions on the morphology and biology of cryptogams the following may be mentioned. Professor West read two papers dealing with his observations on the genus *Microspora* and on *Zygnema ericetorum*: in the former he pointed out that the isolation of *Microspora* in a special order (Microsporales) of the Green Algae should be given up. Dr. Darbishire described the development of the apothecium in the lichen *Peltigera*, in which male organs (spermatia) are very rare, though fruits are formed abundantly, probably by apogamy; no coiled carpogonia can be made out, but there are deeply staining cells which form part of a connected system of branched hyphae proceeding from medulla to cortex, becoming multinucleate by nuclear divisions in the cells and (after producing functionless trichogynes which force their way through the cortex) giving rise to large cells ("ascogonia") from which the asci derive their paired female nuclei. Miss E. M. Poulton described the structure and life history of an aquatic lichen, *Verrucaria margaracea*. In an interesting paper, illustrated by very fine lantern slides, Professor Buller described the structure of the gills in the toadstool genus *Coprinus*, with special reference to the beautiful adaptations shown by the basidia of varying lengths, bearing the spores at different levels, and thus ensuring the liberation of spores in the most efficient manner. The same genus was dealt with by M. L. Baden, who found that, after encountering great difficulty in germinating the spores of *Coprinus sterquilinus* on ordinary media, vigorous germination occurred in media containing abundant bacteria, leading to the conclusion that in some way the bacteria are of benefit to the spores and to the mycelium formed by their germination—possibly by producing substances which soften the spore coat, or by removing any by-products of the fungus which may hinder germination. The apple-canker fungus, *Nectria ditissima*, was described by S. P. Wiltshire, who found that this fungus, which is a genuine wound parasite, can only attack trees when the injury is deep enough for the fungus to reach the wood, and that in nature the chief means of inoculation are injuries made by frost and by the woolly aphis (*Schizoneura lanigera*), in both cases the bark being burst by the swelling of the various tissues; the reäctions of the host against the disease are the formation of phellogen at the limits of the infected region in the cortex, of abnormal wood similar in structure to the medullary rays, and of wound gum in the wood vessels. Miss M. Hume described the structure of the leptoids, or "sieve-tubes," of the moss genus *Polytrichum*, pointing out that these cells have a nucleus though never containing starch grains or large oil drops like the other living cells of the moss stem. Direct experiments indicate that the conducting function of the leptoids is probably confined to albuminous materials and is not concerned with carbohydrates, the latter being possibly conveyed by the hydroids which probably have not a purely water-conducting function.

Dr. R. R. Gates presented and discussed certain evidences to show that mutation and Mendelian splitting are different processes. Results have been obtained showing that some at least of the mutations of *Oenothera* are not due to recombinations of Mendelian characters, as some writers have assumed, but to irregularities in the reducing nuclear division ("meiosis") which lead to changes in nuclear structure. The cases of *O. lata* and *O. semilata* alone were referred to in this paper, because they offer a means of differentiating between characters which are inherited from the parents and those which arise as a result of unequal or irregular distribution of the chromosomes during meiosis: these mutant forms have fifteen chromosomes instead of fourteen, and the same is true of all individuals possessing the foliage and habit of *lata* or *semilata*, even when these characters are associated with others derived by inheritance from their parental forms. Such cases show definitely that mutation is a process which is independent of the recombinations of characters such as occur in hybrids. The source of the fifteen chromosomes was shown some years ago to lie in occasional irregularities in the distribution of the chromosomes during reduction; two pollen grains of a pollen tetrad receive eight chromosomes, and the other two receive six, and when an egg having seven chromosomes is fertilised by a male cell from a pollen grain with eight, the resulting individual will have fifteen chromosomes and the foliage of *lata* or *semilata*. The extra chromosome, which is a triplicate of a pair already present, is thus associated with the development of certain foliage characters in *Oenothera* in the same way that the accessory chromosome, when present in duplicate, is, in certain insects, associated with the development of female sex characters. This is apparently the first case in plants in which a definite relation has been shown to exist between a chromosome and particular external characters.

Physiology was represented mainly by a joint discussion

with the Chemistry Section, which was opened by Professor Moore with an account of various methods of bringing about the synthesis of formaldehyde from carbon dioxide and water by inorganic colloids acting as transformers of light energy; and by a paper in which Mr. W. N. Jones described some recent investigations in pigment (anthocyan) formation.

Ecology was represented by three papers on maritime vegetation. Professor Oliver dealt with the distribution of *Suaeda fruticosa* and its rôle in the stabilising of shingle, pointing out that while all shingle plants to some extent modify or retard the landward movement to which shingle beaches are liable, when very high tides are accompanied by onshore gales, *Suaeda fruticosa*, from its shrubby habit of growth and high capacity of rejuvenescence, is the most effective stabiliser of all British shingle plants. Miss W. H. Wortham described some features of the sand dunes in the south-western corner of Anglesey, with special reference to the succession of the various plant associations; while Mr. P. H. Allen gave a preliminary account of the observations made by a party from the Cambridge University Botany School on the maritime plant associations at Holme, Norfolk, the chief feature of the area being a sandy salt marsh, though there are also sand dunes and shingle banks.

CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A. (Oxon.), F.I.C.

ACTION OF ALKALINE WATER ON LEAD.—The water consumed in Birmingham, which is mainly derived from Wales, is slightly alkaline, and unless subjected to special treatment has a pronounced action upon bright sheet lead. To obviate risk of danger from this cause a small amount of powdered chalk is added to the water in the Welsh reservoirs. The results of experiments upon this solvent action of the water are described by Messrs. Liverseege and Knapp in a communication to the British Association.

In these experiments, which were continued over a period of five years, it was found that different portions of a lead pipe behaved differently in this respect, and that the resistance offered to the water increased with the lapse of time. New lead pipes were rendered more resistant to the action of the water by treatment with a dilute solution of potassium permanganate. The erosion of sheet lead by the water depended upon the simultaneous action of oxygen, and its degree varied with the distance of the metal from the surface.

Carbon dioxide had but little effect in preventing the action of the water unless present in a quantity exceeding two per cent. by volume. Under those conditions the erosion of the lead was stopped, but the metal was dissolved in appreciable quantities. An addition of lime in proportions within the limits of three to nine parts per one hundred thousand reduced the erosive action, but larger or smaller quantities had little, if any, effect. The best results were obtained by treating the water with not less than four parts of calcium carbonate or not less than two parts of calcium bicarbonate per one hundred thousand.

THE FIXATION OF NITROGEN BY FELSPAR.—A mode of decomposing felspar, and its use in the fixation of atmospheric nitrogen, is described by Mr. W. H. Ross in the *Journ. Ind. Eng. Chem.* (1913, V, 725). If a current of nitrogen be passed over a mixture of felspar and carbon which has been heated to a temperature of 1400° C. only a small proportion of the nitrogen is retained by the ignited mass, but by adding calcium carbonate or lime to the mixture a relatively large amount becomes fixed. In the reäction that takes place the potassium of the felspar is liberated and volatilised, and more nitrogen is fixed than would be required to form a nitride of aluminium. For example, a mixture of two parts of felspar, two parts of carbon, and 4·3 parts of calcium carbonate when ignited at 1400° C. in a current of nitrogen fixed 6·1 per cent. of nitrogen in one hour and 7·4 per cent. in two hours. The fixed nitrogen may be very slowly liberated in the form of ammonia by boiling the product of the reäction with water or with a solution of sodium hydroxide.

THE FORMATION OF ALKALOIDS IN PLANTS.—From the results of experiments upon *Datura* and tobacco plants Messrs. Ciamician and Ravenna (*Chem. Zeit.*, 1913, XXXVII, 1156) have drawn the conclusion that vegetable alkaloids may be formed from amino-acids. For example, green tobacco plants normally contain about 0·15 per cent. of nicotine, but by inoculating them with various organic compounds the proportion of alkaloid could be more than doubled. Thus, after treatment of the plant with pyridine tartrate, the amount of nicotine was raised to 0·22 per cent., while with asparagin it was increased to 0·25 per cent., and with benzoic acid and quinol up to 0·4 per cent. Dextrose also led to an increased production of nicotine, whereas phthalic acid caused the proportion to be less than normal. Analogous results were obtained by treating *Datura* plants with pyridine, piperidine and carbopyrrolic acids, the first of these compounds causing the greatest increase in the alkaloidal production. In the case of both plants there was complete assimilation of the added substances.

ABSORPTION OF OXYGEN BY COAL.—An investigation that has an important bearing upon the spontaneous ignition of coal has been made by Mr. T. F. Winmill (*Times, Eng. Suppl.*, Oct. 1st, 1913). In each series of experiments coal-dust from coal taken from different parts of the Barnsley seam was exposed to the air at a temperature of 30° C. and the rate of oxidation determined. It was found that during the first hour or two the rate of absorption of oxygen was very rapid, and that the quantity absorbed was approximately proportional to the nature and amount of the carbonaceous matter present. As much as a tenth of a cubic centimetre of oxygen was absorbed by one hundred grammes of the coal dust during this initial oxidation, which lasted about forty-eight hours. The speed of absorption then became much slower, but it was possible for the increase of temperature produced during the first stage of oxidation to accelerate the velocity of this second stage to such an extent that, given favourable conditions, there was risk of ignition taking place. The reduction of the proportion of oxygen in the air did not prevent the initial oxidation, while the use of coarser coal-dust having only one four-hundredth of the surface of the fine dust only reduced the speed of oxidation by 28 per cent. A rapid increase in the velocity of the absorption followed each increase of the temperature.

MICRO-ORGANISMS PRODUCING ARSINE.—The conditions under which it is possible for arseniuretted hydrogen (arsine) or similar products to be liberated from compounds of arsenic are matters of considerable importance from the public health point of view. Although wall-papers coloured with an arsenic green are not so common as was once the case, they may still be found, and, when exposed to the air, may yield poisonous volatile compounds. At one time it was commonly believed that cases of poisoning by arsenical wall-papers were due to the dry dust given off from the surface, but in 1908 it was proved by Gosio that the real cause was an organic compound of arsenic produced by the action of certain mould-fungi in the presence of the carbohydrates contained in the paste by which the paper was attached to the wall.

This action is strictly specific, and was shown by Neppe (*Scienza Pratica*, 1908, I, 82) to be a characteristic property of the following moulds, arranged in the order of decreasing activity:—*Penicillium brevicaule*, *Aspergillus clavatus*, *A. fumigatus*, *A. glaucus*, *A. virens*, and *Mucor mucedo*.

A certain degree of moisture is necessary for the action of the mould-fungi, and a temperature of about 25° C. (77° F.) promotes the decomposition, which appears to be a direct vital phenomenon. When the amount of arsenic present exceeds a certain proportion the mould-fungi themselves are poisoned, but they can be gradually rendered immune to larger quantities. The volatile compound set free was found by Neppe to be diethyl-arsine, $HAs(C_2H_5)_2$.

A further investigation of the moulds capable of decomposing arsenical compounds in this way has recently been made by Dr. Husz (*Apoth. Zeit.*, 1913, XXVIII, 605). The

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behaviour of ninety different mould-fungi was investigated, and it was found that two forms of *Aspergillus* and five forms of *Penicillium* were the chief micro-organisms possessing this property. Among the moulds growing on arsenical paint on the damp walls of a room there was also a variety of *Actinomyces*, which appeared to be of common occurrence. When grown on culture media this mould formed colonies of a chalk-white appearance, owing to the production of spores.

ATOMIC WEIGHT OF CHLORINE.—Two critical studies of the published determinations of the atomic weight of chlorine are given in the *Chem. Zentralblatt* (1913, II, 572). In the first of these by Dr. A. Guye, the collated results obtained by the classic method of precipitating the chlorine with silver give the atomic weight as 35·454, this value being dependent upon the atomic weight of silver, which is taken as 107·87 to 107·88. By the more modern method of calculating the atomic weight from the vapour density, chlorine shows the value 35·461, which corresponds to an atomic weight of 107·89 for silver. The calculations of M. E. Wourtzel are in substantial agreement with those of Dr. Guye. Taking the atomic weight of hydrogen as 1·0076 and that of nitrogen as 14·008, the corresponding atomic weight of chlorine was found to be 35·460.

ENGINEERING AND METALLURGICAL.

By T. STENHOUSE, B.Sc., A.R.S.M., F.I.C.

CORROSION OF CONDENSER TUBES.—Sir Gerald A. Muntz, Bart., and Professor H. C. H. Carpenter, M.A., Ph.D., the Chairman and Hon. Secretary respectively of the Corrosion Committee of the Institute of Metals, have prepared a statement of a further scheme of work planned by the Committee. A short summary of the experimental work already accomplished was given in the last number of "KNOWLEDGE." The new work to be undertaken includes a time-temperature survey of the conditions under which dezincification of condenser tubes can take place, and a more detailed study of the temperatures existing in the experimental condensing plant and other condensers. Special attention will also be directed to the conditions under which electro-chemical protection can be effectively maintained, and in this connection a comparative study of all the principal methods of holding tubes in tube-plates will be carried out. A systematic series of experiments will also be initiated with a set of tubes of a copper-aluminium alloy from which specially interesting results are anticipated. The work will be carried out by Dr. G. D. Bengough, M.A., the Hon. Investigator, the expenses being met by subscriptions to the Corrosion Research Fund of the Institute of Metals. The contributions received to date since the establishment of the fund in January, 1911, amount to nearly £800.

BRITISH ASSOCIATION—SECTION G.—The report of the Committee to Section G of the British Association, on "Certain of the more complex stress distributions in Engineering Materials," gives a review, with bibliography, of the literature dealing with combined and alternating stresses. In notes contributed by Dr. F. Rogers, the usual causes of the failure of metals under alternating stress are summarised in the three main classes:—(*a*) *Flaws*, including pipes, fissures, blow-holes, impurity, and non-metallic enclosures. (*b*) *Faulty original heat-treatment* of pure metal. This includes as a special case, strains set up in manufacture, and overwork in the working processes. (*c*) *Under-estimation of stresses* to be expected, on the part of the designer. This includes as a special case insufficient allowance for the effect of repetition of a stress which would be harmless if applied once or steadily maintained.

The Heat Treatment of steel, as affecting endurance, may conveniently be considered in three main classes:—(1) *Overheating*, which must be distinguished from "burning," in general, diminishes the endurance under alternating stress. (2) *Reheating through the critical range* is, in general, capable *per se* of bringing the endurance to a normal high value. (3) *The speed of cooling through the critical range* has in any event a most profound influence upon the endurance under alternating stress. Generally speaking, it appears that the more rapid this cooling the greater is this endurance.

GEOGRAPHY.

By A. STEVENS, M.A., B.Sc.

FIORDS.—The work on the Nature and Origin of Fiords, just published by Mr. Murray for Professor J. W. Gregory, will arouse much interest. Fiords have generally been ascribed to glacial action, but Professor Gregory advances reason for believing that they are the result of earth-movements and faulting, and succeeds at least in discrediting the glacial hypothesis. First of all, it is not true that fiords occur only in glaciated regions, for typical fiords occur in the unglaciated areas of Dalmatia and the North Island of New Zealand. Then it is certain that at least the Scottish fiords are pre-Glacial in age, and the direction of glaciation is often transverse to the line of the fiords, as is shown remarkably in the Shetland Isles, where the ice movement was from east to west, while the inlets are strikingly arranged in a north and south direction. Taking the Scottish lochs for example, they are seen to follow four well-marked sets of lines, trending north-east, north-west, east, and north. Fissure-systems running in these directions are frequent and typical in Scotland. Of these the first is the most striking, and the Caledonian Canal with its line of lochs, and the persistence of the line in the northern shore of the Cromarty Firth and the coast of Sutherland and Caithness, is the most remarkable example. This system is dependent on the well-known Great Glen fault. In the north-west system the branch of Loch Awe, for instance, runs in the Pass of Brander, which is also a fault valley. Then the arrangement of fiords is not that which a glacier system would produce. There is no hint of radiating from central high land that would inevitably be seen in features due to ice, and side fiords join a main fiord of one system from directions that associate them with other systems. It is not only in Scotland that the fiords are associated with the ascertained crack-systems of the country. The phenomenon is seen in Spitzbergen, Dalmatia, and in the other regions described. The distribution of fiords is significant and correlated with the different types of movement characteristic of polar and equatorial regions. They occur mainly on western coasts where the piling up of elevations of the earth's crust is greatest, and just beyond which has taken place extensive foundering; and this distribution is dependent on the rotation of the earth. The crack-systems are associated with the foundering of the ocean-beds. Two fiord belts exist, the northern nearer the pole than the southern, on account of the tetrahedral plan of the earth. Along fiord coasts typical fiords are found in the higher latitudes, and pass towards the equator into fiards, which in turn give place to rias. In the fiord regions themselves, in the higher latitudes, are wider rift-inlets and sounds associated with typical networks of true fissure fiords, and nearer the equator the wider rift channels disappear, and only the fiord reticula remain. This succession is wonderfully constant.

GEOLOGY.

By G. W. TYRRELL, A.R.C.Sc., F.G.S.

CALCITE CRYSTALS FROM A WATER TANK.—In view of the frequent occurrence of crystals of carbonates, especially dolomite, in certain argillaceous sediments, the observations of the late R. F. Gwinnell on calcite crystals formed in a water-tank are of interest (*Mineralogical Magazine*, July, 1913). The crystals were deposited in sand-like heaps in a tank into which water was led, through an old leaden pipe, from a spring in the ferruginous beds at the base of the Marlstone (Middle Lias) to the north of Grantham, Lincolnshire. They were formed during the dry summer of 1911, when the flow of water, although not ceasing, was

reduced to a mere trickle. Under microscopic examination the crystals were found to be colourless, of rhombohedral habit, and giving the usual tests for calcite. This determination was confirmed by chemical analysis, which showed that the deposit contained 95·65 per cent. of calcium carbonate, the rest being alumina, ferric oxide, and silica. The deposition of these crystals under artificial conditions of comparative aridity has a bearing on the formation of similar carbonate crystals in ancient sediments laid down under arid conditions, under which direct precipitation of carbonates from solution may well have taken place.

LAND CLASSIFICATION AND GEOLOGY.—Recently the people of the United States became aware that they had been too lavish with their lands, and that more than half the public domain had been alienated. Now, therefore, the examination and classification of the public lands has been made an essential preliminary to their disposition and development, and the Geological Survey was commissioned to carry out a scientific examination of the lands still remaining to the nation. Pending the accumulation of this quantitative knowledge the land is withdrawn from settlement and exploitation; but as soon as any area is accurately known, and its highest use ascertained, it is restored to entry, and is so disposed as to secure the maximum benefit to both settler and State. From the results of geological examination by its field officers the Land Classification Board of the United States Geological Survey is enabled to say whether the highest utilisation of certain areas may be attained by working metalliferous deposits, coal, oil, gas, phosphate, or salines, or by using it as a reservoir or water-power site, or merely as agricultural land. On the basis of information thus obtained the public-land administrative officers make the most useful allocation of the land that is possible. In the case of coal a most exact quantitative survey is made, and a valuation becomes possible. After classification and valuation the lands are restored to entry, and may be acquired under the coal-land laws at the valuation prices. Prior to land-classification many persons fraudulently obtained coal and other valuable mineral lands under the cheap and easy mode of entry relating to agricultural lands. The principles, purposes, and methods of land classification are explained in Bulletin 537 of the United States Geological Survey, which makes most interesting reading. It presents a clear formulation of a new method in which the science of geology is made of practical value to the public. Although it is rather late in the day to voice the sentiment it is perhaps a pity that all the public land of our own country is so hopelessly alienated.

ORIGIN OF TEKTITES.—Under the term "tektite," Professor Suess includes all the peculiar pebbles of obsidian-like glass which have been described under the names of moldavite, billitonite, and australite. These have frequently been assigned an extra-terrestrial origin; and Dunn regards australites as the blebs from the bases of glass-bubbles ejected from volcanoes and distributed by the wind over the Australian plains (see "KNOWLEDGE," August, 1913, page 308). G. P. Merrill has recently compared tektites with a series of undoubted obsidian pebbles from various localities in North and South America and Iceland, and finds that the latter have the same structures and peculiarities of surface-markings as the tektites. Moreover, he shows that the chemical composition of one of these obsidian pebbles does not sensibly differ from that of tektites (*Proceedings U. S. Nat. Mus.*, 1911, 481–6). Dr. Merrill concludes that while the theory of the meteoric origin of tektites is not controverted by these observations, it cannot be regarded as proved until these bodies have actually been seen to fall on to the earth's surface.

In connection with Dunn's theory of the origin of australites, the observation by Mr. F. W. Moon of volcanic ash in Mexico, consisting largely of perfect bubbles of volcanic glass, is of great interest and importance (see letter in "KNOWLEDGE," November, 1913, page 409). It proves what Dunn was unable to prove, that volcanic glass-bubbles are capable of being formed and of being distributed over the earth. More information concerning this occurrence is desirable.

METEOROLOGY.

By WILLIAM MARRIOTT, F.R.MET.SOC.

DURATION OF RAINFALL.—It is generally believed in this country that every other day is a wet one. This supposition is approximately correct, as the number of "rain days" in the year is about the same as the number of rainless days. A "rain day" is held by meteorologists to be a day on which an amount of 0·01 inch or more fell during the twenty-four hours ending 9 a.m. of the next day. This may be spread over the whole twenty-four hours, or it may only occupy a few minutes in falling, but it gives no information as to the actual duration of the rainfall. This can only be obtained from self-recording rain-gauges, and it is satisfactory to learn from *British Rainfall* that there is an increase in the number of these instruments in use.

At Camden Square, London, where a Casella self-recording rain-gauge has been in use since 1881, the following are the average values for the thirty-one years, 1881–1911 :—

Rainfall.	Duration.	Intensity rate per hour.	Rain days.
24·13-in.	426·9 hours.	·057-in.	162

In 1912 the values were :—

Rainfall.	Duration.	Intensity rate per hour.	Rain days.
27·88-in.	516·2 hours.	·054-in.	180

The duration in 1912 exceeded the average by twenty-one per cent., and the number of rain days eleven per cent. in excess of the average for the same period; the year was thus one of very persistent rainfall, but with an intensity slightly below the normal.

The following values from the same class of instrument show the monthly duration of rainfall in hours at several stations in various parts of the country during 1912 :—

Station	London.	Thrapston, Northants.	Cirencester, Glos.	Hodsock, Notts.	Southport, Lancs.	Cray Reservoir, Brecon.
Height above sea-level	111-ft.	262-ft.	366-ft.	56-ft.	39-ft.	1030-ft.
January...	88·8	89·8	110·8	108·7	105·0	236·0
February	44·7	39·5	58·5	29·9	53·8	179·3
March ...	59·8	51·9	106·7	60·2	115·7	220·2
April ...	1·6	1·8	4·8	2·0	6·6	40·8
May ...	25·8	24·2	33·7	49·8	62·4	88·5
June ...	54·2	56·1	68·3	60·3	71·8	132·2
July ...	22·2	60·1	46·5	48·5	49·6	104·8
August ...	66·2	100·3	106·3	72·5	96·0	189·5
September	25·7	24·5	19·3	24·5	30·4	33·7
October...	32·1	41·3	67·8	25·9	62·7	134·5
November	37·2	35·1	38·9	37·8	56·1	143·3
December	57·9	55·7	100·8	36·3	73·2	242·2
Year ...	516·2	580·3	762·4	556·4	783·3	1745·0
Rainfall...	27·88	31·36	42·01	33·45	37·13	82·83

April stands out prominently as a very dry month, the duration of rainfall in many districts being less than two hours. The months of greatest duration were January, March, and August. It is interesting to notice that in the mountainous districts, where there is a heavy rainfall, the duration is considerably greater than at stations at a much lower elevation.

TORNADO IN WALES.—We are accustomed to think that tornados only occur in the United States and that nothing of the kind is likely to be experienced in the British Isles. On Monday, October 27th, however, a little after 5 p.m., a most violent storm of the tornado type, accompanied by vivid lightning and heavy rain, occurred in South Wales and passed over the district in which Senghenydd is situated, where the recent appalling colliery disaster occurred. From the accounts in the local papers it appears that the storm started on the mountain west of Treforest and rushed up the

eastern side of the Taff Valley to Cilfynydd, whence it roared up Cwm Eldeg, and then over the north-eastern flank of Llanfabon Mountain, and down into the Taff Valley. From here it rushed up the western side of the valley, and expended its fury upon the highest houses in Abercynon. It then seems to have turned off at a tangent to Quaker's Yard and Treharris, where its career apparently ended. The track of the tornado was only about two hundred yards in width, but within this area everything was devastated. Mr. Clement Edwards, M.P., in an appeal for monetary help for the sufferers, states that many hundreds of houses have been ruinously damaged, and that over two hundred families have lost beyond repair most of their furniture and all their bedding and bedclothes and wearing apparel. Among the more extraordinary effects of the storm it may be mentioned that half a corrugated iron roof was carried for several miles, through valleys, across villages, and over mountain tops, and the tins of the sheets detached and wound round posts as a doctor wraps a bandage round a broken wrist. A four-ton oak tree was carried away for nearly a quarter of a mile. Unfortunately two men lost their lives, one being caught by the fury of the storm and hurled a distance of one hundred and fifty yards into a field, and the other being struck on the head by a slate.

EFFECT OF ATMOSPHERIC CONDITIONS ON WIRELESS SIGNALS.—Dr. E. W. Marchant read a paper at the recent meeting of the British Association on the effect of atmospheric conditions on the strength of wireless signals sent out from the Eiffel Tower in Paris at 10.45 a.m. and 11.45 p.m., and received at Liverpool. The results obtained show that there is a maximum variation from 0·6 to 1·3 in the strength of the signals received on different days in the same month; the average strength of signal being assumed to be 1·1, and that the current received on a fine clear night is about 1·7 times as strong as that received in the daytime.

Although no certain relationship can yet be regarded as established between the strength of a signal and the weather conditions at the sending and receiving stations, so far observation has shown that rain in Paris always corresponds with diminution in strength of received signal. In one case, with a wind of six meters per second velocity, blowing in a north-west direction, the signal-strength fell to half its normal value. The most favourable condition for signalling appears to be a cloudy sky at both sending and receiving stations, the signals being weaker when the sky is clear or covered with light clouds. Rain at the receiving station appears to have a comparatively small influence on the strength of the received signals. The result of a set of special signals sent from the Eiffel Tower on the evening of Saturday, July 26th, 1913 (by the courteous arrangement of Comm. Ferrié), at intervals of thirty minutes, between 7 and 10 p.m. (which includes the time of sunset), shows that the increase in strength of night signals occurs just after sunset, there being an abrupt increase in strength of about 70 per cent. This change is quite sudden, there being comparatively little alteration in signal-strength until the sun has set, and no perceptible increase in strength afterwards. There appears to be some evidence that signals are slightly stronger just after sunset than during normal night conditions.

MICROSCOPY.

By F.R.M.S.

DENDROMONAS VIRGARIA WEISSE.—At one of the excursions of the Quekett Club during the autumn the above-named organism was obtained in some quantity; though probably not very rare, it is certainly not frequently recorded. Owing to its exceeding transparency and delicacy, and the small size of the composing units, it would be easily over-looked by anyone unacquainted with it. Saville Kent gives an excellent representation of it from which Figure 535 is taken.* As will be seen it is a tree-like form. The stem, called the "zoödendrium," is rigid, dichotomous, and copiously branched. At the end of each branch is attached a somewhat flattened pear-shaped animalcule, the forward end obliquely truncated. It has two flagella of unequal length, and is without a mouth, food being taken in at all parts of the body. It has a nucleus and one or two contractile vacuoles, and is practically a stalked monad. The whole is perfectly transparent, and while the individuals are extremely small--about 8μ in length—the entire organism is of considerable size, often consisting of more than one hundred zoöids, and being about 1–130″ in height. In consequence it is very difficult to observe satisfactorily. For finding it and for a general view a half-inch objective with good dark background illumination answers, but for anything like a complete examination the highest power that can be brought to bear on the object is necessary, with a careful adjustment of light; the use of a coloured screen is advantageous. In the present instance, specimens were fairly numerous on some fine grass stems which had evidently been submerged a long time, but it was not found possible to preserve them long under examination, as the zoöids soon became detached from the pedicle; the stem and branches, however, remained visible afterwards. In most of the specimens it was noticeable that the animalcules were arranged on a more regular level than the illustration indicates, the mass forming, when looked at from the side, a thin plate on the top of the beautifully hyaline regularly-branched stem. In a surface view, at least in the larger specimens, the pear-shaped bodies were seen considerably compressed towards the middle of the group owing to crowding, and were often angular in consequence. Kent says of it: "Among all of the numerous stock-building pedicellate varieties of the Flagellata, few, perhaps, excel the present one in the exuberance of growth and graceful symmetry of the erect branching zoödendrium. The associated colonial stocks have been observed in such abundance on the finely-divided leaves of Myriophyllum and other water plants as to present the aspect of a perfect forest growth of tiny crystal trees, each terminal leaflet replete with life, and quivering with the combined vibratory action of their flagella." Figure 535 represents an adult colony; at A is an isolated monad under high magnification; and at B a colony of two monads in process of longitudinal division, all from Saville Kent's "Manual of the Infusoria."

JAS. BURTON.

QUEKETT MICROSCOPICAL CLUB.—October 28th, S. C. Akehurst, "A changer for use with substage condensers." This was on the principle of the Zeiss sliding objective changers.

S. C. Akehurst, "A trap for free-swimming organisms." This was exhibited in two forms and took advantage of the phototropism exhibited by most pond animals.

James Murray, "The Gastrotricha": a valuable contribution dealing with this small group of minute animals, chiefly freshwater, and of doubtful affinity. The paper describes their form and structure, their haunts and habits, gives a historical sketch of the group with its classification, a key to the genera, and a list of the eighty-three species, including one new one, which have been described, and concludes with a lengthy annotated bibliography. The paper, with a plate of some forty figures, appears at length in the November issue of the Club's *Journal*.

E. M. Nelson on "An improved form of Cheshire's Apertometer" and M. A. Ainslie, "A variation of Cheshire's Apertometer"; two papers describing improvements designed to facilitate and render accurate determinations of the second decimal place of N.A. with this instrument.

F. J. Cheshire did not think the form of Apertometer he had introduced some ten years ago capable of greater accuracy than he had then given it. He described another method of estimating N.A. which he considered an improvement on the older one.

PHOTOGRAPHY.

By EDGAR SENIOR.

TESTING FOR "HYPO" IN MOUNTS, PRINTS, AND WASHING WATER.—If silver prints are mounted upon card that contains traces of "hypo" owing to this body

* "Manual of the Infusoria." Plate XVII, Figure 1.

having been used as an "antichlor" in neutralising the bleaching agent used in the manufacture of the paper or the material from which it was made, its presence may bring about fading of the print. On this account mounts for silver prints should be selected with considerable care. There are, however, several delicate tests that may be applied which will detect "hypo," even when present in very small quantity, the following being one of them. Take about three or four square inches of the card to be tested and tear it up into small pieces and put these to soak in a glass beaker which is about half filled with distilled water, after which add about half a dram of pure strong sulphuric acid and a little pure zinc. The beaker is then to be covered with a piece of filter paper upon which a few drops of a solution of lead acetate have been allowed to fall. The presence of "hypo" will be indicated by the acetate of lead becoming brown from the formation of lead sulphide, and if after the expiration of about half an hour there is no appearance of stains, it may be assumed that "hypo" is absent. In any case the rapidity with which the stains are developed will depend upon the quantity of "hypo" present. The test depends upon the nascent hydrogen evolved by the action of the sulphuric acid upon the zinc, reducing the sodium thiosulphate ("hypo"), with the formation of sulphuretted hydrogen, which combines with the lead acetate to form lead sulphide, the reäctions being expressed by the equations

$$Na_2S_2O_3 + 4H_2 + H_2SO_4 = 2SH_2 + Na_2SO_4 + 3H_2O$$

$$Pb\,(CH_3COO)_2 + SH_2 = PbS + 2\,(CH_3COOH)$$

The presence of "hypo" in prints may readily be detected in a number of ways, the iodide of starch test being commonly employed for the purpose, the solution being made up in the following manner. A small piece of starch is taken and boiled in about three drams of distilled water until a clear solution is obtained, to which when cold about a dram of iodine dissolved in alcohol is added: this causes a dark-blue coloured solution to be produced due to the formation of iodide of starch. "The addition of iodine dissolved in water by the aid of potassium iodide will answer instead of iodine in alcohol." To apply this test to ascertain whether "hypo" is present in a print, small pieces of the latter are boiled in a test tube containing some distilled water; the solution is then allowed to get quite cold when one or two drops of the iodide of starch are added to it, and should the blue colour be discharged the presence of "hypo" is indicated, but should the blue colour remain it may be assumed that this salt is absent. The presence of "hypo" in the washing water of prints is readily shown by taking two test tubes and filling one with pure distilled water and the other with the water to be tested, and if a drop or two of the iodide of starch solution be added to each, sufficient to give a faint blue colour to one when viewed by looking through it at white paper, a total absence of any colour in the other will show that "hypo" is present in it. The presence of "hypo" is also easily shown by means of an alkaline solution of potassium permanganate, for which purpose the following formula by Professor Bottcher is to be recommended:—

Potassium permanganate (pure)	...	...	1½ grains
Caustic soda	...	...	15½ „
Water (distilled)	...	...	18½ ounces

When using this solution the presence of "hypo" is shown by the pink colour changing to a green, owing to the reduction of the manganese salts. The washing should therefore be continued until a small quantity of the water contained in a test tube will allow of some of the pink solution being added to it without its becoming green.

PHYSICS.

By ALFRED C. EGERTON, B.Sc.

SPARK PHOTOGRAPHS AT HIGH PRESSURES.—The curious phenomena which attend the passage of electricity through gases are manifold; the nature of the effect is chiefly dependent on the pressure. At ordinary pressures the usual spark discharge is obtained; as the pressure increases, so it becomes more and more difficult for the spark to pass: the length of the air gap must be decreased, and when the discharge passes a fatter spark is obtained and a larger current is carried across the gap. At low pressures, the discharge passes more readily until a certain lower limit of pressure is reached, when the discharge passes again with great difficulty. The discharge first appears as an elongated spark; then as a straight but rather fuzzy strip; then it fills the whole space between the two electrodes, and then appears the Faraday dark space near the negative electrode, which is surrounded by a luminous glow; then, again, behind this appears the Crookes dark space, where the negative electrons are ejected normally to the surface of the electrode. As this space begins to show, so the discharge usually breaks up into a series of light and dark bands. Finally the Crookes space fills the whole tube, and if exhaustion is carried very much further the space refuses to carry any discharge of electricity.

The study of these phenomena has led to the wonderful developments of physical science during the last twenty years. The positive, the negative or kathode, and the X-rays and the rays they in turn give rise to—secondary rays—were all discovered during investigations to explain these electric discharges; indeed, much light has been thrown on the nature of matter and its relation to electricity by such work done mainly by Sir J. J. Thomson and those who have been inspired by his genius. An atom of matter is built up of negative charges of electricity, some free to move as they will, others bound, some controlling the chemical properties of the atom, others resident within and taking no part in chemical actions. These negative charges are held together by the rest of the atom which is positively charged. Whether this charge is concentrated in a central nucleus or whether it is distributed throughout the mass of the atom is still an open question; the positive portion is associated with the chief portion of the mass of the atom. The effects obtained in the electric discharge in gases are mainly due to the action of charged particles (electrons) or positively charged atoms on the molecules of gas in their path. If the velocity of the charged particle is sufficient it will "ionise" the molecule on collision with it; that is to say, it will split it into oppositely charged parts. The current is carried at the lower pressures by these moving ions.

The explanation of the discharge through gases at high and ordinary pressures is dependent on similar considerations. A discharge will pass through some gases more readily than others; through neon the discharge passes most readily. In most cases of the conveyance of electricity through gases the ions have to be produced by some kind of rays, but in the spark discharge there are many more ions produced in a given time in the neighbourhood of the electrodes than recombine in the same time, and the discharge, as it were, "supports itself." The differences in the ease with which the discharge will pass through the gas depend on the amount of energy required to ionise the molecules of the gas. Investigations on these matters have been most ably carried out by Professor Townsend, of Oxford.

Amongst the mass of literature on these subjects we may note a paper read before the Röntgen Society in April, 1913, by Professor A. W. Porter. The terminals of an induction coil are connected to two electrodes, one on either side of a photographic plate. The photographic plate is situated in a dark chamber, in which the pressure may be raised up to ten atmospheres. When the negative electrode is against the sensitive side of the plate, at ordinary pressures, fanlike impressions of the discharge are obtained on developing the plate; but on raising the pressure the fanlike expansions separate into two filaments. The negative discharge gives figures with lines of discharge which are characteristic of the positive spark lines for the same gas; that is, a positive rebound must occur after the negative discharge has taken place.

The distinction between the negative and positive discharges is very marked, but they are somewhat more similar at higher pressures. The fanlike discharges are shown to be due to the presence of nitrogen. The spark in oxygen

XUM

passes easily and the effects at higher pressures obtained with air are due to the presence of oxygen, the negative discharge in nitrogen being very difficult to obtain at high pressures. In hydrogen the discharge merely amounts to a glow round the terminal. The positive discharges, when the positive electrode is put against the sensitive side of the plate, are not so distinctly different in different gases, and they merely become finer at higher pressures. These experiments will help to define many curious effects obtained in the brush and spark discharge, but there is much which remains to be cleared up. The actual condition of affairs at the negative electrode is, perhaps, one of the most interesting points upon which the above researches may throw some light.

ZOÖLOGY.

By PROFESSOR J. ARTHUR THOMSON, M.A., LL.D.

COMMENSAL CRUSTACEANS IN CHAETOPTERUS TUBES.—Professor A. S. Pearse has studied three Crustaceans — *Polyonyx macrocheles*, *Pinnixa chaetopterana*, and *Pinnotheres maculatus*—which occur as commensals in the tubes of *Chaetopterus variopedatus* at Wood's Hole. The two first-named are not closely related, *Polyonyx* being a Galatheid and *Pinnixa* a true crab of the family of Pinnotherids, but they have many similarities. Like most Crustaceans, they are strongly thigmotropic, and creep into crevices or tubes, which would easily account for their taking up their abode with Chaetopterus. They are rarely found elsewhere. They become quiet when a shadow passes over them, which has probably protective value. They feed by "net casting," after the manner of barnacles, and this is admirably suited for the capture of food within the tubes. The "nets" in both are formed by the inner blades (or endopodites) of the third maxillipede, which are well supplied with plumose setae and are swept through the water. Both forms have the last leg shortened. Both have a long breeding season, producing one brood after another, and this is perhaps fostered by the sheltered life. They gain from their association with the worm, but the worm's view of the situation is unknown.

REMARKABLE BLIND CEPHALOPODS.—One of the most precious spoils of the Michael Sars North Atlantic Deep Sea Expedition of 1910 (carried out under the auspices of the Norwegian Government and the superintendence of Sir John Murray and Dr. Johan Hjort) was a blind cuttlefish, *Cirrothauma murrayi* n. g. et sp. apparently adapted for deep sea life. Three thousand metres of wire were out when it was captured. The specimen is perfectly gelatinous and semi-transparent. Its fragility recalls that of a Ctenophore. A delicate web unites the arms. The nerves can be seen shining through the whole length of the arms. The gelatinous body exhibits an exceedingly faint violet colour, and only the parts round the mouth, the proximal portions of the arms, and the web exhibit the purple chocolate colour peculiar to many deep-sea animals. Chromatophores are absent, except a rhombic one between the two fins. Very peculiar minute suckers (thirty-six in number) poised on long spindle-shaped and clumsy stalks of gelatinous substance occur on the inner side of the arms. They are evidently out of function, being flattened and without a sucking pit, and smaller than the normal proximal suckers. In each stalk there is a curious structure which may be a luminescent organ and reflector. The eye is minute, without a lens, with a very degenerate retina and optic nerve. There are deep-sea cuttlefishes with small eyes, but no case save this one is known where the structure of the eye is involved. Its degeneration has gone further than in many blind vertebrates.

PHOSPHORESCENCE OF PENNATULIDS.—Professor W. A. Herdman has recently described the "phosphorescence" of *Funiculina quadrangularis*, the largest British Pennatulid. The light on the bare part of the colony was more intense that that produced by the polyps. "The long bare lower part of the stem, nine inches to a foot in length, when gently stroked in the dark glows with a continuous sheet of light of (it seems to me) a pale green colour which flickers or pulsates like a lambent flame." In *Pennatula phosphorea* the luminosity seems to be confined to the polyps. It is more general and more lasting than the sparkles that the polyps give in *Funiculina*. In the report on the spoils of the Michael Sars Expedition, the artist has given a figure of the luminescence of *Umbellula güntheri* which was still brilliantly phosphorescent although drawn up from the immense depth of more than five thousand metres. Dr. Hjalmar Broch refers to Sir Wyville Thomson's note that the spectrum of Pennatulid phosphorescence is very restricted and sharply included between b and D. Niedermeyer found that the phosphorescence of *Pteroeides griseum* was restricted to the polyps and small zooids, and is temporarily lost after exposure to sunshine, which probably destroys, for the time being, the product of some intracellular secretion. Although its phosphorescence is only seen by us when we stimulate these Pennatulids, Broch suggests that deep-sea forms may show it without irritation.

NOTICES.

CHANGE OF ADDRESS.—We are asked to announce that Messrs. Haseltine, Lake & Company, Patent Agents, have removed from 7 and 8, to No. 28, Southampton Buildings, Chancery Lane, E.C.

OPTICAL LANTERNS.—Messrs. Newton & Company's new catalogue is noteworthy for the many types of science lanterns listed, and is particularly valuable on account of the variety of arc lamps and other projection illuminants therein described.

SCIENTIFIC BOOKS.—We have received from Mr. H. K. Lewis his quarterly list of new books added to the circulating library. It contains the books published from July to September. Under the heading, "Technology," we notice that the first volume of the new edition of Lewkowitsch's "Chemical Technology and Analysis of Oils, Fats, and Waxes" is included.

THE "WELLCOME" PHOTOGRAPHIC RECORD AND DIARY, 1914.—This useful little pocket guide to photography has been reissued by Messrs. Burroughs, Wellcome & Company. Particular attention is given in this edition to blue and green toning and the production of various colours by development. It should find a place in every photographer's library.

SCIENTIFIC, INDUSTRIAL AND TECHNICAL BOOKS.—Messrs. Crosby, Lockwood & Son have published a new illustrated catalogue of books coming under the above heading, and we are asked to announce that they will be willing to send a copy post free to all who may be in any way interested.

SECOND-HAND MICROSCOPES.—Messrs. H. F. Angus and Company have issued their fourth catalogue under this title. A good selection of instruments, objectives, and accessories, as well as general optical and physical apparatus, will be found therein.

NATURAL HISTORY BOOKS.—In Messrs. John Wheldon & Company's latest catalogue will be found, besides general literature, a list of important remainders of books on Natural History, and many sets of scientific journals, both English and foreign.

THE SCIENTIST'S REFERENCE BOOK AND DIARY, 1914.—Once again we have pleasure in noting the appearance of this handy pocket book. In addition to a diary and space for memoranda it contains tables useful for everyday reference and a short account of the progress of science in 1913. It is published by Messrs. James Woolley, Sons & Company, Limited, of Manchester.

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